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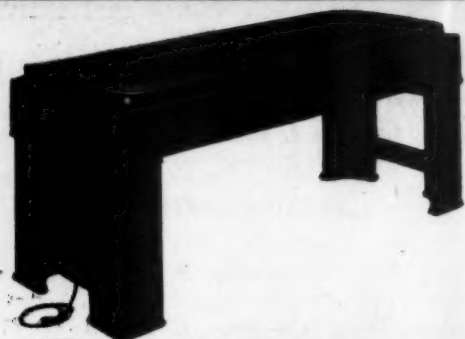
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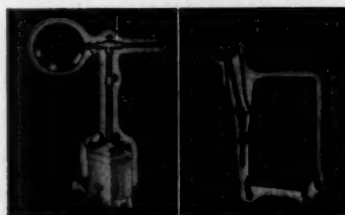
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STUDIES ON MUSCLE INNERVATION IN POLIOMYELITIS AND NERVE INJURIES *

ARTHUR L. WATKINS, M.D.

and

MARY A. B. BRAZIER, Ph.D.

BOSTON

An important aspect of physical medicine is the evaluation of muscular function. In poliomyelitis this has been accomplished in the past chiefly by tests of manual strength, grading performance under standardized conditions. The results of these tests have been found useful to physical therapy physicians in planning muscle reeducation and to surgeons in determining orthopedic procedure. In recent years more sensitive methods of study have been developed and also methods allowing quantitation of various components of muscle function. These technics are of particular interest in relation to physical medicine, as they make possible the evaluation of therapeutic agents.

To aid in the problems of diagnosis and prognosis of peripheral nerve injuries, measurements of muscle innervation more sensitive than the galvanic and faradic tests are especially useful, since they give early information as to regeneration.

This report deals with the application of such methods to the evaluation of muscle innervation in poliomyelitis and peripheral nerve injuries.

Poliomyelitis

Tests of Muscle Strength. — The most commonly used methods to assay the strength of muscles in poliomyelitis are similar to that described by Lovett.¹ In this type of examination the strength of individual muscles is graded according to performance against gravitational or manual resistance in prescribed positions. When such tests are repeated by an observer who is well trained in this method of examination, the results can be of considerable practical value. There is inevitably, however, a large subjective element in such evaluations, and for this reason we have attempted to develop more exact measurements of muscle strength.

For this purpose an ergograph has been used, a description of which has been previously published.² With this mechanical device the affected muscles perform the work of lifting a known weight repeatedly at a regulated speed. Each excursion of the weight is recorded on a revolving drum by a pen actuated through a string and pulley. An additional device attached to this apparatus enables the operator to quantitate the total amount of work done. This consists of a ticker tape on a revolving wheel, the tape being pulled through a ratchet each time the weight is lifted, in a length equal to the distance traveled by the weight. In this way the total elevation of the weight can be measured by the length of the tape passing through

* From the Physical Medicine Department and the Electromyographic Laboratory of the Massachusetts General Hospital.

Aided by a grant from the National Foundation for Infantile Paralysis, Inc.

* Read at the Twenty-Third Annual Session of the American Congress of Physical Medicine, Cleveland, Sept. 9, 1944.

1. Lovett, R. W.: *Treatment of Infantile Paralysis*, ed. 2, Philadelphia, P. Blakiston's Son & Co., 1917, p. 132-162.

2. Schwab, R. S.; Watkins, A. L., and Brazier, M. A. B.: *Quantitation of Muscular Function in Cases of Poliomyelitis and other Motor Nerve Lesions*, Arch. Neurol. & Psychiat. 50:538 (Nov.) 1943.

the ratchet, this figure multiplied by the weight used equaling the amount of work done. In addition to the measurement of the total work accomplished, the tracing on the drum records the onset and rate of fatigue. The results of a series of such ergographic determinations are shown in figure 1.

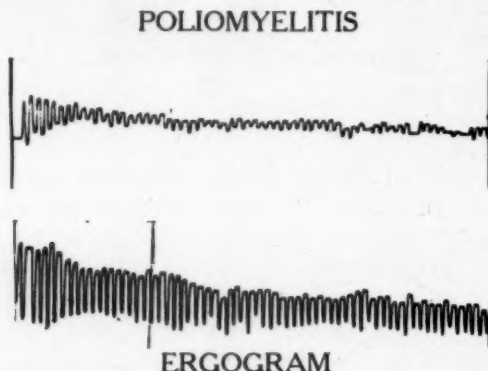


Fig. 1. — Ergograms of dorsiflexion of the foot during convalescence from poliomyelitis. In the upper record, made two months after onset, 26 kilogram-centimeters of work were accomplished in two minutes. In the lower tracing, made four months after onset, 203 kilogram-centimeters of work were done in the same length of time.

The subjective element of voluntary effort is not, of course, eliminated by this method, but with care in the arrangement of the apparatus and with cooperative patients it has been found to be a useful measurement taken as an adjunct to other methods of study. There is also the advantage that simultaneous electromyographic recordings of action potentials may be made and used as an additional measurement of muscular function. The method of recording the latter will be described later.

Electrical Excitability. — The threshold response of muscles to electrical current is commonly used to determine their state of innervation. It is well known that four or more days after a nerve injury the contractile response of the muscle to make or break of a direct current shock is altered in its character. Instead of a brisk twitch, a slow wavelike contraction results. A denervated muscle also fails to respond to a tetanizing current, such as faradic or 60 cycle alternating current. This change in electrical excitability is known as the reaction of degeneration. This is of clinical value in the hands of an experienced observer, since it gives qualitative information as to the degree of muscle innervation. Such tests have not been used to any great extent in poliomyelitis because in this disease there may be a combination of innervated and denervated muscle fibers in the same muscle group, making interpretation of results difficult. The objection has also been raised that this method of testing is painful and tends to increase muscle sensitivity.

A method of electrical testing giving some quantitative information is that of determining the chronaxie of the affected muscle. Condenser discharges of varying voltages and capacity are used for this purpose. The duration threshold of response to a current of arbitrarily set intensity (twice the rheobase) is the important measurement (chronaxie). Objections to this method are that it is based on a conception of a universal time factor and that results are greatly influenced by variation in type, position, and size of electrodes, and also that changes in the voltage parameter of the

voltage-capacity relationship in degenerating nerves may appear without alterations in the time parameter or chronaxie.³

We have accordingly studied the electrical excitability of affected muscles with currents of varying strength and duration so that the threshold excitability could be graphically shown in the form of a curve plotted on logarithmic paper. In this technic the stimulus is a condenser discharge varying from 0.001 to 10 microfarads and from 1 to 400 volts. Muscles were usually stimulated at the motor point by a hypodermic needle electrode inserted in the muscle or by a small hand electrode held at constant pressure as indicated by a spring balance incorporated in the handle. The reliability of this method is to a great extent dependent on the choice of end point taken by the observer. For consistency of results the smallest detectable contraction is used as the end point. In the case of the surface electrode this is a minimal movement of the skin overlying the contracting muscle and with the needle electrode a just perceptible movement of the projecting shank. Less variation is encountered with the needle electrode because it eliminates effects due to changes in skin resistance and the thickness of subcutaneous tissue. Since multiple readings add to the reliability of this method, eight to sixteen observations are made on each muscle.

These studies on electrical excitability yielded interesting information as to recovery and prognosis in poliomyelitis. When the tests were repeated at weekly or biweekly intervals the voltage capacity curves could be compared, and these gave a graphic index of the degree of motor innervation. When the electrical excitability became progressively worse a poor prognosis was apparent. In most cases, however, successive tests showed gradually improving excitability (fig. 2). This would indicate accordingly

POLIOMYELITIS

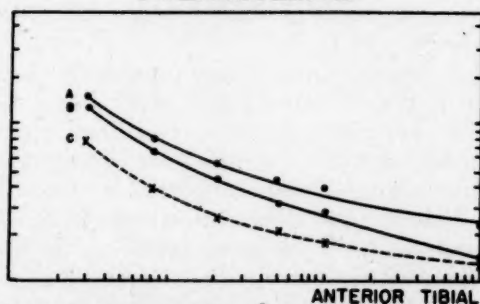


Fig. 2. — Voltage-capacity curves during recovery from poliomyelitis: A, three months after onset; B, seven months later; C, normal control. The patient is the same as in figures 1 and 3. Ordinate, \log_{10} voltage; abscissa, \log_{10} capacity.

that the usual improvement in muscle strength of patients convalescing from poliomyelitis is not due entirely to increased function of nonaffected motor units but indicates an actual recovery process in damaged units. As anterior horn cells are thought to be incapable of regeneration, one is led to speculate that the pathologic recovery is due to reversible lesions in some of these cells, perhaps in the nature of chromatolysis.

Electromyograms. — As previously mentioned, action potentials can be recorded from working muscles during ergographic tests. These are recorded by a standard ink-writing oscillograph, bipolar surface electrodes being used according to methods previously described.² The voltage of these action potentials has been found to give a good index of the contractile power and to correlate well with the manual and ergographic tests (fig. 3). A

3. Rosenblueth, A., and Dempsey, E. W. A Study of Wallerian Degeneration, *Am. J. Physiol.* 120: 19 (Dec.) 1939.

POLIOMYELITIS

ANTERIOR TIBIAL



Fig. 3. — Action potentials of dorsiflexion of the foot recorded simultaneously with the ergograms in figure 1, two months and four months after onset. Under each electromyogram are two signal records. The lower one is the time marker, which records every second; the upper one, the integrator, which trips the signal at every condenser discharge. (Calibration: 1 signal per 700 microvolts.)

further quantitation is possible by means of an integrator which registers the total voltage discharged during the test period.

Electromyograms have also yielded valuable information as to the degree, distribution and nature of muscle irritability in poliomyelitis. The results of these studies have formed the basis of separate reports.⁴

The finding of spontaneous electrical discharges from resting muscles during the convalescent period has given us further evidence that there is a recovery process. These discharges have the same pattern as those recorded from a muscle whose nerve is known to be regenerating after a peripheral injury. Their appearance coincides with other evidence of re-innervation of the muscle, such as improved electrical excitability and increased motor power.

Another aspect of muscle innervation of particular interest to the physical therapy physician is the coordination of muscles during voluntary movement. Simultaneous electromyographic recordings from the antagonistic muscles of an extremity provide a method for studying reciprocal innervation. In poliomyelitis, patients with considerable weakness or painful motion showed marked disruption of normal innervation during movement. The muscles with antagonistic function were found to be simultaneously activated in these instances. This abnormality decreased as the muscle strength improved and with muscle reeducation or therapy for the relief of pain (fig. 4). Another more severe disorder of innervation was demonstrated by electromyograms which revealed not only simultaneous contraction but actual synchrony of individual action potentials in opposing muscles (fig. 5). This disorder was found only in the most severely paretic patients and could not be overcome by muscle reeducation.

We have concluded that these various methods for studying muscle innervation in poliomyelitis are of value in quantitating the degree of muscle involvement and the effects of therapy. Some information has also been added as to the types of muscle dysfunction in this disease, such as muscle irritability, paralysis and incoordination. Evidence has also been presented which suggests that a recovery process may take place in motor units.

Peripheral Nerve Injuries

The same methods of clinical laboratory investigation have been applied

4. Watkins, A. L.; Brazier, M. A. B., and Schwab, R. S.: Concepts of Muscle Dysfunction in Poliomyelitis, *J. A. M. A.* 123:188 (Sept. 25) 1943. Brazier, M. A. B.; Watkins, A. L., and Schwab, R. S.: Electromyographic Studies of Muscle Dysfunction in Infectious Polyneuritis and Poliomyelitis, *New England J. Med.* 230:185 (Feb. 17) 1944.

POLIOMYELITIS

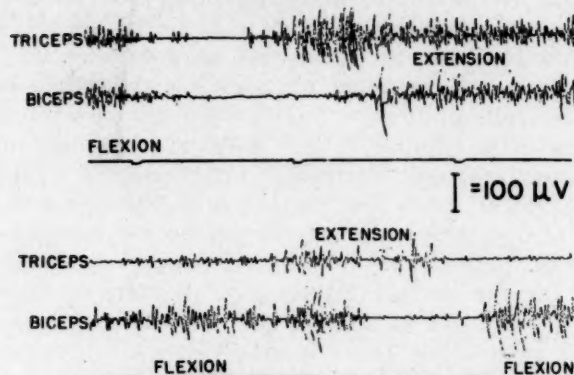


Fig. 4. — Action potentials during alternate flexion and extension of the elbow in a patient with poliomyelitis. In the upper tracings, made fifteen weeks after onset, opposing muscles are simultaneously activated. In the lower record, made six months after onset, reciprocal innervation is restored.

POLIOMYELITIS

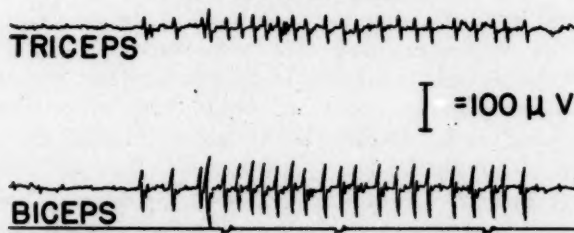


Fig. 5. — Synchronous action potentials in opposing weak muscles during active elbow flexion seven months after onset of poliomyelitis.

to patients with peripheral nerve injuries. The evaluation of individual muscle function according to the usual manual tests is useful in charting the anatomic distribution of the lesion. The more sensitive tests of electrical excitability are employed to assess the degree of nerve injury and to determine the onset of regeneration. The galvanic and faradic tests may be used to considerable advantage provided their limitations are recognized. Five to ten days after the trauma, compression and stretch injuries of relatively minor degree can be differentiated by this method from more severe lesions, including severance. In the case of a mild compression injury, although paralysis is complete owing to loss of nerve conduction, the electrical excitability is little altered, for the muscle gives an excellent response to the faradic current. Persistence of faradic response, therefore, aids in making this diagnosis and gives information on which to base a good prognosis for a spontaneous recovery within a few weeks.

In those cases in which a reaction of degeneration is present, however, it is impossible, by this test, to differentiate a loss of continuity from a severe stretch or compression injury. Experience has also shown that this electrical test is not of great value in giving evidence of neural regeneration at an early date. Return of voluntary motion often precedes return of response to faradic stimulation. Experienced observers, nevertheless, are sometimes able to detect changes in the character of response to galvanic stimulation which indicate the beginning of muscle reinnervation. These changes are in the nature of a more brisk muscle twitch.

Generators which provide a galvanic current with a slowly rising increase in potential are useful in detecting other alterations in muscle response to stimulation. Muscles with normal nerve supply have a higher threshold of response, since they are able to accommodate to these slow changes in potential. Denervated muscles, on the other hand, lose this power of accommodation and respond with a wavelike contraction. At the beginning of reinnervation of muscle there may be some diminution in the response to these slow galvanic currents. Interpretation of the results from these tests is dependent solely on the skill and experience of the examiner, since no objective measurements are recordable for comparison. For this reason more exact methods of determining electrical excitability are recommended, such as the voltage capacity studies already described. These tests have been found to be of considerable clinical usefulness, for objective measurements of excitability may reveal evidence of regeneration several weeks before definite clinical signs of returning function appear and before changes in response to galvanic and faradic currents occur. This method has been used in a large number of cases of peripheral nerve injury and has proved to be of considerable aid in establishing evidence of successful nerve suture or in indicating the necessity for operation.

Electromyograms. — The study of denervated muscles by means of electromyographic recordings has also been of real practical value in peripheral nerve injuries. By this method it is possible at an early stage to differentiate easily reversible minor lesions from more severe traumatic paralyses. In the case of minor lesions, action potentials are recordable on attempts to contract the paralyzed muscles; these are not found in completely denervated muscles, although the paralyses may be clinically indistinguishable.

Electromyograms are of unique value in signaling the onset of reinnervation of paralyzed muscles, since motor unit activity can be detected only by this means. The initial return of motor unit function is characterized by the spontaneous appearance of electrical discharges from resting muscle. These have a distinctive pattern consisting of singly occurring diphasic spikes which are impossible to reproduce voluntarily. Examples of such activity are shown in figure 6. These tracings show the progress of regeneration in the nerve down the arm, it being apparent in the forearm before it reaches the hand. This activity is recordable four to eight weeks before function can be detected clinically. Although sufficient material has not yet been studied to warrant a definite conclusion, it is our present opinion that these electromyographic phenomena precede the changes in electrical excitability as measured by voltage capacity curves. Electromyograms, therefore, appear to be the most sensitive method of detecting minimal innervation of muscle.

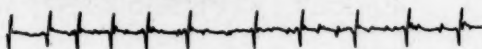
As in the case of poliomyelitis, the voltage of action potentials during ergographic tests may be used as an objective measurement of the recovery of muscle function after peripheral nerve injury.

Electromyograms were also valuable in localizing impairment of muscle innervation due to lesions of nerve roots resulting from ruptured intervertebral disks. In such cases, spontaneous discharges may be recorded from resting muscles whose nerve supply is so minimally affected that no clinical sign of impairment is apparent. The distribution of these abnormal discharges is useful in determining the specific root involved (fig. 7).

Data on muscle innervation made available by these methods are of distinct aid to clinical diagnosis and prognosis of nerve injuries and may furnish information unobtainable by other means.

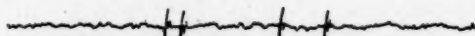
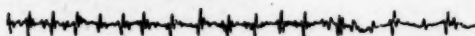
MEDIAN NERVE INJURY

FLEXOR CARPI



ABDUCTOR POLLICIS

FLEXOR CARPI



ABDUCTOR POLLICIS

 $I = 100 \mu V$

Fig. 6. — Spontaneous discharges in paralyzed muscles during nerve regeneration after median nerve injury. In the upper tracing, (made six months after injury), only the flexor carpi radialis shows reinnervation. In the lower record, (made one year after injury), regeneration has reached the abductor pollicis brevis.

RUPTURED DISC

BICEPS

 $I = 100 \mu V$

TRICEPS

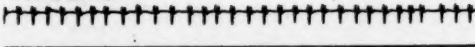


Fig. 7. — Spontaneous discharges in the triceps but not in the biceps, indicating compression of the seventh cervical root.

Summary

Quantitative studies of muscle innervation in poliomyelitis and nerve injuries are of value in physical medicine.

1. Measurements of motor power and fatigue are objectively recorded by an ergograph.
2. Voltage-capacity curves of electrical excitability give quantitative information as to neuronal damage in poliomyelitis. In peripheral nerve injuries this method aids in the detection of regeneration.
3. Electromyograms of action potentials are an additional index of muscle function.
4. Spontaneous electrical discharges from muscles at rest are sensitive indicators of reinnervation.

In poliomyelitis the application of these methods reveals a recovery process in the motor unit. Accurate evaluation of nerve injuries is facilitated by these technics.

Discussions will appear in a later issue.

ARTIFICIAL FEVER AND CHEMOTHERAPY IN EARLY SYPHILIS *

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ELSIE MILLER, B.A.

and

WALTER M. SIMPSON, M.D.

DAYTON, OHIO

During the past decade there has been developing a sufficiently wide experience with artificial fever therapy (physically induced), on the part of many workers in this and foreign countries, to justify the statement that this modality has taken its place as one of the most effective methods in the management of symptomatic and asymptomatic neurosyphilis. One has only to refer to the reports of the Committee on Nonspecific Therapy of Syphilis,¹ Barnacle, Ebaugh and Ewalt,² Bennett and co-workers,³ Bromberg,⁴ Trautman,⁵ Neymann,⁶ Hinsie and Blalock⁷ and Simpson and co-workers⁸ for unequivocal data on its application to neurosyphilis.

During the period in which artificial fever combined with chemotherapy was used in the treatment of neurosyphilis, patients with other manifestations, such as interstitial keratitis, uveitis and other ocular involvements, periostitis and osteomyelitis, osteitis and gumma, eighth nerve deafness and tertiary lesions of the skin and mucous membranes, were subjected to the same routine with equally good results. As a natural sequel, attention was directed to the use of the combined therapy for early syphilis. Those who might consider the sequence illogical should ask themselves the question,

From the Kettering Institute for Medical Research, Miami Valley Hospital, Dayton, Ohio.

*Read at the Twenty-First Annual Session of the American Congress of Physical Therapy, Pittsburgh, Sept. 11, 1942.

1. O'Leary, Paul A.; Breutsch, Walter L.; Ebaugh, Franklin G.; Simpson, W. M.; Solomon, Harry C.; Warren, Stafford, L., and Vonderlehr, A. A. (Committee on Non-Specific Therapy, U. S. P. H. S.) Assisted by Usilton, Lida J., and Sollins, I. V.: *Malaria and Artificial Fever in the Treatment of Paresis*, J. A. M. A. 115:677 (Aug. 31) 1940.
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"Why wouldn't this method of treatment, which is effective in arresting neurosyphilis, be equally effective in preventing such devastating manifestations if applied in the early phase of the disease?" The theory has been put into practice by many investigators, and reports have shown the combined treatment to be sufficiently effective in animals and man to justify the statement that both clinical "cure" and serologic reversal may be accomplished.

In 1932 we began our investigation of the effect of combined artificial fever and chemotherapy in early syphilis. During the period from 1932 to 1940 we subjected 77 patients with primary or secondary syphilis to the combined therapy. During the first six years the course consisted of approximately fifty hours of fever maintained at an average temperature of 105.8 F. (rectal), usually given in ten weekly sessions of five hours each. From 1937 to 1940 the course comprised in average of twelve shorter sessions (three hours), usually at more frequent intervals (twice or thrice each week), for an average total of thirty-six hours of fever maintained at the

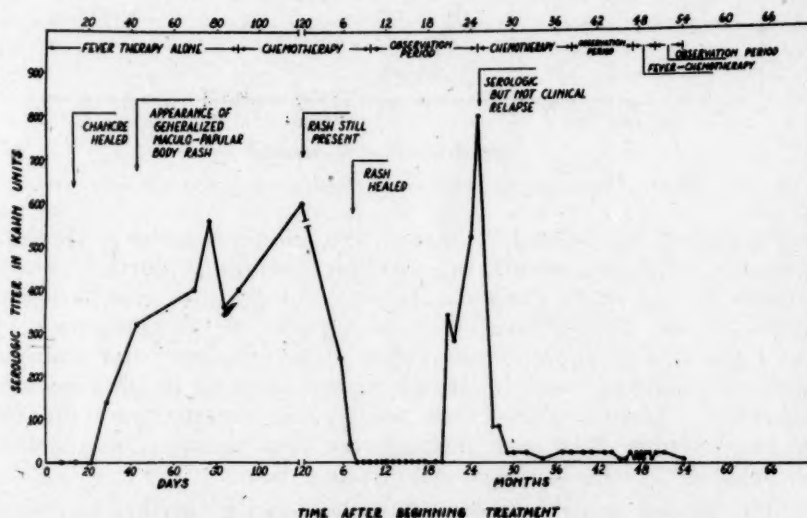


Chart 1.—Results of combined fever therapy and chemotherapy in a case of early syphilis.

same average temperature. No essential difference either in the clinical or in the serologic response, as measured by the quantitative Kahn⁹ titer, was observed in the two groups.

At the outset of the experiment it was decided to institute control studies to determine the efficacy of fever therapy alone and of chemotherapy alone, of the same amount and kind as that used for patients treated by a combination of the two methods. After 6 patients with primary or secondary syphilis had been treated solely with a total of fifty hours of fever, it was deemed unwise to continue with this part of the experiment because clinical relapse occurred in 2 patients. A significant development of this study was the observation that clinical relapse could be anticipated for the most part by changes in the quantitative serologic titer. The clinical course and the quantitative serologic course of 2 typical patients are shown in charts 1 and 2.

In the patient represented by chart 1, *Spirochaeta pallida* could not be demonstrated on dark field examination of the secretion from the primary penile lesion after the first fever session and the lesion healed rapidly; the

9. The sensitized Kahn antigen was employed in performing the serologic tests.

serologic reaction of the blood became positive on the twentieth day after the first fever treatment; the quantitative serologic titer continued to rise for three weeks, until it reached 320, when there appeared a generalized maculopapular eruption.

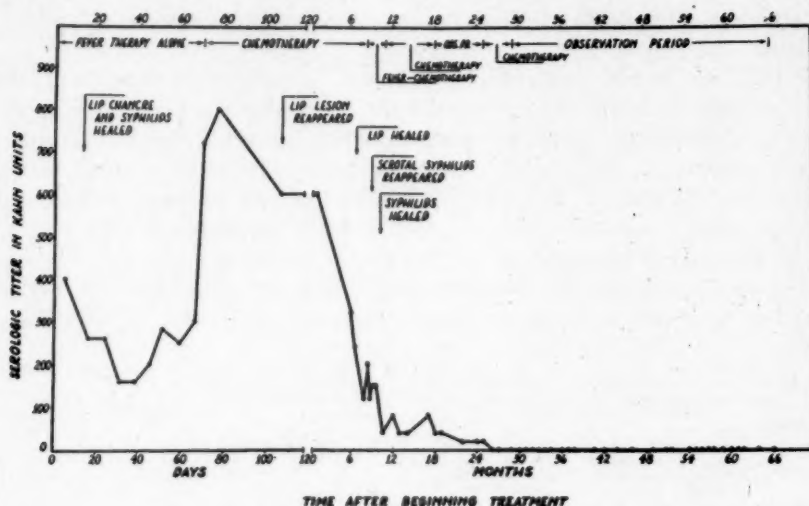


Chart 2.—Results of combined fever therapy and chemotherapy in a case of early syphilis.

In the patient represented by chart 2, the progressive rise in the serologic titer began more than a month before clinical relapse occurred. Indeed, in the patients in this series the quantitative serologic titer rose progressively during the course of fever treatments in advance of the appearance of new lesions of the skin or mucous membrane. The serologic titer continued to rise until chemotherapy was instituted, either alone or in combination with fever therapy. Then a prompt fall occurred in the titer, accompanied by clinical improvement. In each instance the clinical status was anticipated by the behavior of the serologic quantitative titer.

Of the second control group, 15 patients with primary or secondary syphilis to whom thirty concurrent injections of arsenic and bismuth compounds were given, 4 exhibited clinical relapse. Chemotherapy alone, as applied in this control group, was inadequate.

Of the 77 patients treated for early syphilis with combined fever and chemotherapy, the records of 17 were not included in the analysis because of lack of adequate follow-up examinations. The 60 patients who were re-examined clinically and serologically at frequent intervals were classified as follows: seronegative and dark field positive primary syphilis, 8 patients; seropositive primary syphilis, 20 patients; late secondary syphilis, 8 patients. The period of observation after the combined course of treatment varied from two to ten years. The 8 patients included in the group with seronegative primary syphilis have remained negative both clinically and serologically. Of the 24 patients in the group with seropositive syphilis, 22 exhibited a rapid and progressive decline to negativity, both clinically and serologically. The tests of the other 2 became negative after a second course of combined treatment. Of the 20 patients with early secondary syphilis, all but 2 achieved clinical and serologic negativity after treatment. The 2 refractory patients required additional fever-chemotherapy before their serologic reactions reversed to negative. In the group of 8 patients with secondary manifestations occurring between the first and second years of the

disease, 5 responded both clinically and serologically. The remaining 3 were improved, but required additional fever-chemotherapy to attain complete clinical remission and ultimately serologic negativity.

It is noteworthy that in none of these patients did the syphilitic manifestations progress and in none did symptomatic or asymptomatic neurosyphilis develop.

Some interesting observations with reference to serologic responses were made in the course of this study: 1. There is no correlation between the height of the initial serologic titer and the clinical status of the patient. Clinically comparable patients exhibit great variation in initial serologic titers. 2. Under conditions of adequate treatment the decline in serologic titer occurs at a constant rate. 3. Under conditions of adequate treatment the time rate of serologic reversal to negative appears to be a function of the height of the initial titer; the lower the initial titer, the more rapid the reversal. 4. From a statistical standpoint, intensification of treatment by administration of combined artificial fever and chemotherapy at semiweekly intervals does not appear to be more efficacious, as measured by the Kahn quantitative procedure, than administration of the same type of treatment at weekly

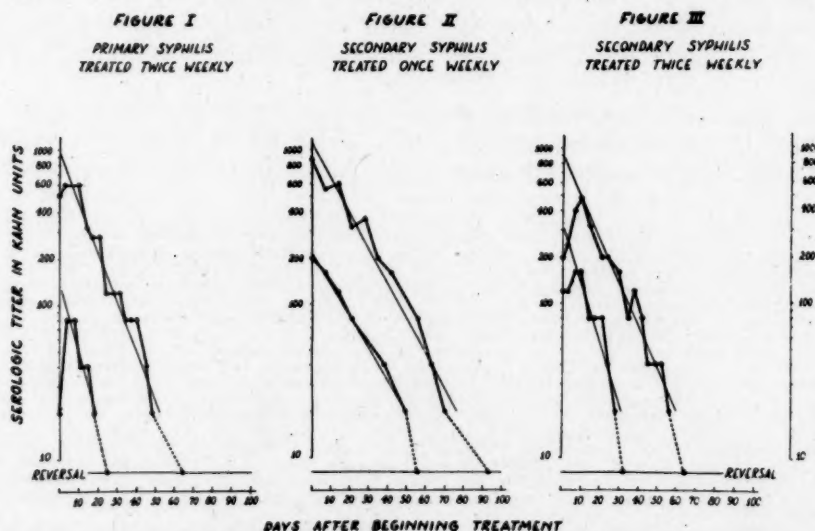


Chart 3. — Curves showing the course of the serologic titer in three groups of patients.

intervals. Chart 3 presents curves showing the course of the serologic titers in three groups. The titers, as measured by Kahn units, are plotted logarithmically against time in days on a linear scale. Figure I is based on titers of 2 patients in the group with primary syphilis treated twice weekly, figure II on titers of 2 patients in the group with secondary syphilis treated once weekly and figure III on titers of 2 patients in the group with secondary syphilis treated twice weekly. The decline in titer tends to follow a straight line. In fact, a straight line drawn through the curve would represent an ideal which the titers of the Kahn quantitative procedure follow closely. Such an ideal curve is represented by the faint straight line.

In all groups treated, by fever or chemotherapy alone and by combined artificial fever and chemotherapy, the quantitative Kahn titer was determined throughout the period of treatment and at weekly intervals until negativity was attained. Then serologic specimens were examined at monthly intervals for the first year and at sixth month to yearly intervals thereafter.

Among the workers who have given us a rich background of experi-

mental studies of animals and of human subjects are, notably, Weichbrodt and Jahnel,¹⁰ Bessemans and associates,¹¹ Schamberg and Rule,¹² Carpenter, Boak and Warren,¹³ Levaditi and de Rothschild,¹⁴ Kolmer¹⁵ and Simpson.¹⁶ Their results provide convincing evidence of the unfavorable influence of high body temperature on *Spirochaeta pallida*.

Of particular interest are the recent experiments of Boak, Carpenter and Warren,¹⁷ which were designed to determine the effects produced by combining subcurative chemotherapy with subcurative artificial fever therapy in the treatment of experimental syphilis of rabbits. Notwithstanding the fact that many investigators (Kyrle,¹⁸ Richet and Dublineau,¹⁹ Simpson and Kendell,²⁰ Neymann, Lawless and Osborne²¹) have found convincing clinical and immunologic evidence that fever therapy combined with chemotherapy is more effective than either agent employed singly in the treatment of early syphilis in human beings, the Rochester investigators felt that additional experimental data were needed to establish the combined method as an accepted therapeutic procedure for early syphilis in human subjects. Two strains of *Spirochaeta pallida*, the Nichols and the Zinsser-Hopkins strains, were employed. Syphilis was produced in chinchilla rabbits by intratesticular injections of a suspension of spirochetes (confirmed by dark field examination) derived by trituration in a mortar of tissue from the testes and from the popliteal lymph nodes of animals presenting prominent syphilitic lesions.

As soon as unequivocal syphilitic lesions developed (in one to three months), 127 rabbits were treated in one of six ways. Twenty-three of the rabbits received a single subcurative injection of neoarsphenamine (10 mg.

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per kilogram of body weight), followed by a single three hour fever session at a rectal temperature of 106.7 F. (41.5 C.); all were cured. Clinical examinations were carried out for from one to three months, after which the animals were killed and suspensions of testicular and popliteal lymph node tissues were injected into normal rabbits; no clinical or serologic evidence of syphilis appeared in these rabbits during a minimum period of six months. Further verification of cure was established by the successful transfer of the infection to normal control rabbits at a later date.

Twenty-one syphilitic rabbits were given the same amount of neoarsphenamine, followed by a four hour session of fever, for the purpose of determining the possible advantage of an additional hour of fever. All but 1 (95 per cent) were cured. Thus, of 44 syphilitic rabbits treated with a single subcurative dose of neoarsphenamine followed immediately by a subcurative session of fever therapy for three or four hours, 43 (98 per cent) were cured.

For the purpose of comparing the efficacy of the combined treatment when the drug was administered immediately after the fever session rather than before, 20 syphilitic rabbits were given a three hour session of fever at the same level, followed by an injection of the same quantity of neoarsphenamine. The results were distinctly inferior—only 15 (75 per cent) were cured.

Fourteen syphilitic rabbits received no treatment as a control test for spontaneous cure; all remained infected. Tissue transfers made from those animals invariably resulted in the infection of normal rabbits. Ten control rabbits received only a single injection of neoarsphenamine, the dose ranging from 10 to 20 mg. per kilogram of body weight. Only 3 (33 per cent) were cured. As a control on the subcurative effect of either a three hour or a four hour session of fever alone, 39 rabbits received five, six or seven hour sessions of fever (without neoarsphenamine). Only 4 (10 per cent) were cured.

It is then, quite apparent that a subcurative dose of neoarsphenamine combined with a subcurative session of artificial fever gives superior results in the treatment of experimental syphilis in rabbits when compared with the administration of greater amounts of the drug or of fever alone. The time of administration of the antisyphilitic drug in relation to the fever is particularly significant. The results were distinctly better when the drug was administered immediately prior to, rather than immediately after the fever session.

Encouraged by the foregoing observations and by the remarkable work of Chargin, Leifer and Hyman²² on the "five day" massive dose chemotherapy of early syphilis by the intravenous drip method, we began an investigation in February, 1940 to determine whether it might be possible to abolish the disease in one day by combining large doses of mapharsen and bismuth with one session of artificial fever.

For intensive treatment, only patients were selected who had unequivocal evidence of early syphilis. All presented primary or secondary lesions, the secretions from which showed *Spirochaeta pallida*, and none had received

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previous treatment for syphilis. Thirty-seven patients have been included in this study.

On each patient a complete diagnostic survey was carried out. Serologic and spinal fluid examinations, as well as other indicated laboratory procedures, were performed. The patients were hospitalized and treated according to the following therapeutic program:

Just before the fever treatment was begun, an intramuscular injection of 4 grains of bismuth subsalicylate (150 mg. of elemental bismuth) was administered. The patient was then placed in the hypertherm and given a ten hour session of fever at 106 F. (rectal). The arsenical preparation used was mapharsen and was the same for all patients, but the quantity and method of administration differed. Seven of the patients received 240 mg. of mapharsen by intravenous drip during the fever session. This procedure was abandoned in favor of administration of the drug by syringe in 40 or 60 mg. doses. The first injection was given as soon as the rectal temperature reached 106 F., and the remaining injections were spaced at regular intervals during treatment. Nine patients were given two 60 mg. injections (120 mg.); 1 received four 60 mg. injections (140 mg.); 11 were given four 40 mg. injections (160 mg.). No other treatment was administered subsequently.

In this group of patients 3 were female and 34 male. Six had secondary syphilis, and the remaining 31 had primary genital lesions. After the ten hour session of fever at 106 F. (rectal) combined with the amounts of chemotherapy described in the preceding paragraph, the lesions healed within one to two weeks. The healing time was dependent on the extent of the lesion at the time of treatment, as well as on the amount of secondary infection present. It was independent of the amount of chemotherapy administered with the ten hour session of fever and was no different from that of those patients who, as described previously, had received the shorter sessions of fever at weekly and semiweekly intervals. Repeated dark field examinations immediately after treatment and later revealed no motile spirochetes. The 7 patients whose serologic tests were negative at the time treatment was instituted have continued to have negative reactions to date. The remainder of the patients, with the exception of one who died (whose case will be described in detail later) and of another who failed to return for follow-up examinations, showed serologic reversal and their reactions have remained negative to date. Of the patients who received intensive treatment, 29 were observed for from two and half years to six months and 6 were followed for from four to six months.

Specimens of blood were secured for Kahn quantitative serologic examinations at weekly intervals after treatment until negativity was attained. Thereafter, serologic examinations were made at monthly intervals for six months and then every six months.

The serologic course of the 28 patients²³ whose Kahn tests were positive at the institution of treatment was remarkably constant. Chart 4 demonstrates the trend in the serologic titers of 7 representative members of the group. In this chart are shown the variations in the initial serum potency in what appeared to be clinically similar cases. The rate of decline of the titer, however, is roughly parallel for all 7 patients and, likewise, for those not represented. Again, as shown in preceding charts, the quantitative titer of the individual serums declined so constantly that a straight line passes through a majority of the points on the curve. Also, it is to be noted that the time required for serologic reversal to negative is, in general, a function

23. Of these patients, 23 were reported on in part 3 of the paper titled "Quantitative Serologic Studies in Early Syphilis," by D. L. Rose; W. M. Simpson, and H. W. Kendell, published in *Veneral Disease Information*, volume 23, page 411, Nov., 1942.

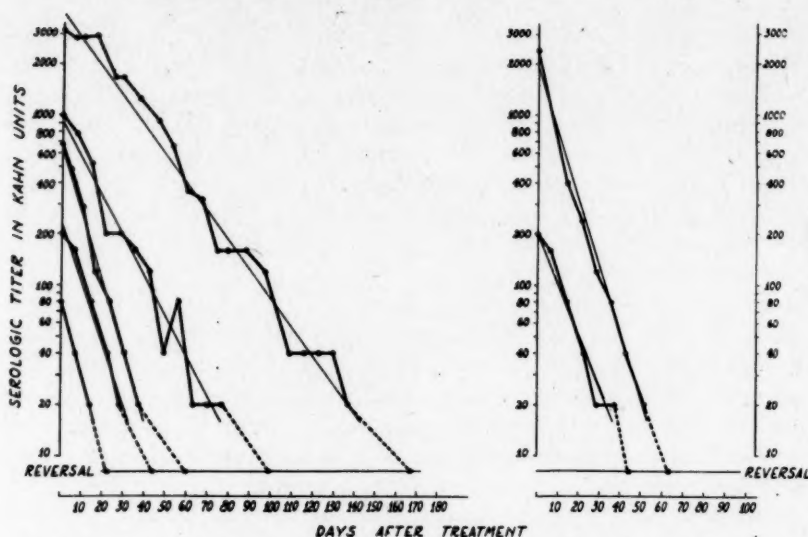


Chart 4. — Serologic titers of 7 patients with primary syphilis after a single intensive treatment with artificial fever combined with chemotherapy.

of the height of the titer. There was no correlation between the time required for serologic reversal and the amount of chemotherapy administered.

A temporary initial rise in titer ("provocative effect") following treatment was observed in 10 instances. In these cases a rise in serologic titer of 40 to 360 units was noted four to thirteen days after treatment; thereafter the titer steadily declined to negativity in the same fashion as that of other members of the group.

One patient deserves individual comment. He had exhibited an initial serologic titer of 3,160 units (chart 4), and a generalized maculopapular eruption developed on the day after treatment. The eruption lasted for approximately one week before fading completely. As is noted in chart 4, after an initial fall in titer of 2,840 units there was an increase of 2,920 units before the progressive fall in titer was observed. The eruption had completely disappeared by the time the titer had reached 2,920 units. No further lesions were observed during the period in which the serologic titer declined to negativity.

From a study of the Kahn quantitative serologic reactions in this group, it might be concluded that (1) the progressive decline in titer to negativity is essentially the same as that noted for patients receiving a larger total amount of both artificial fever and chemotherapy over a longer period and that serologic reversal to negativity in cases of early syphilis is related to the height of the pretreatment titer—the lower the titer the more rapid is the reversal.

In this group of 37 patients, laboratory studies other than the serologic tests already discussed were carried out. The fundamental question of what happens to the arsenic and heavy metals after injection, either alone or in combination with artificial fever, was considered a pertinent problem. Hence, in September, 1940, in collaboration with Doctors Kehoe and Ashe and their associates in the Kettering Laboratory of Applied Physiology at the University of Cincinnati, a program was instituted for study of arsenic excretion by patients being treated for early syphilis. Its purpose was to determine the distribution of arsenic in the tissues of animals and human beings, as well as the alimentary and urinary elimination of arsenic, after intravenous injections of the organic arsenical mapharsen.

Several types of experiment were carried out on human beings. The concentration and rate of appearance of arsenic in the urine of normal subjects was determined. Stillborn fetuses were analyzed to determine whether or not organic arsenicals could penetrate the fetal tissues. The levels of arsenic in the blood of patients with primary and secondary syphilis treated with large doses of an arsenical (mapharsen) given intravenously and simultaneously with artificial fever in the Kettering hypertherm were followed for approximately two weeks, and the levels in the spinal fluid were determined before and after therapy.

In the group of patients with primary and secondary syphilis treated with artificial fever and chemotherapy and in the group who received the five day drip (1,000 to 1,100) mg. in five days, in eight hour session), specimens of spinal fluid failed to show any arsenic. It is not safe, however, to say that arsenic does not penetrate the brain if none is found in the spinal fluid. That it does penetrate the brain was substantiated in a quantitative analysis of tissues from a patient (mentioned in a preceding paragraph) who died three days after receiving 180 mg. of mapharsen by continuous drip during ten hours of fever at a temperature of 106 F. (rectal). It is important to discuss this more in detail.

Prior to this time, all patients subjected to this routine had been young adults. The aforementioned patient, however, was a 42 year old woman with generalized papular secondary lesions, deeply ulcerated mucocutaneous lesions and marked secondary infection. Clinical and laboratory studies failed to reveal anything abnormal, other than the secondary syphilis, except a menopausal syndrome, exhibited for the most part as a mild psychosis. The patient had lost weight during the two months prior to admission.

The patient's contact occurred in December, 1940, and the first subjective clinical evidence appeared March 1, 1941, manifested as a primary lesion of the vulva. A secondary eruption appeared on March 11. Between that day and the treatment, seven days later, the eruption became generalized, covering all skin surfaces of the body and the mucous membranes of the mouth and vagina. Death occurred three days after treatment. Post-mortem examination revealed terminal right cardiac dilatation with terminal pulmonary congestion, edema and small thrombotic infarcts; marked cloudy swelling and fatty degenerative infiltration of the liver; marked fatty infiltration of the kidney; early atherosclerosis; acute passive congestion of all organs, and massive hemorrhage into the stomach by diapedesis.

The concentrations of arsenic of all tissues were studied quantitatively. As might be expected, the liver (1.8 mg.) and kidney (0.565 mg.) showed the largest concentration per hundred grams of tissue analyzed. The brain was examined in anatomic divisions, and the medulla showed approximately four times the concentration of the remaining sections.²⁴

No conclusions can be drawn from studies carried out to date as to the exact level of arsenic in the blood which can be considered curative. The most significant contributions have been the establishment of two reliable methods for determining the level of arsenic in biologic material and a demonstration of the difference of human and animal modes and rates of excretion. With both of the two intensive treatment technics studied, it appears that high levels of arsenic in the tissues are maintained for from several days to perhaps weeks.

In addition to the studies described hematologic tests, blood chemistry determinations and complete urinalyses were made before, during and after the treatment period. As we learned from our previous experiences with

patients undergoing artificial fever, the specific gravity of the serum²⁵ appears to serve as a guide in determining the trend of hydration and dehydration. However, it should be emphasized that all available laboratory methods, correlated with clinical signs and symptoms, should be employed if the extent of hydration or dehydration is to be established. Of the 37 patients, 6 showed no significant change in specific gravity during fever-chemotherapy and subsequently demonstrated practically no change from pretreatment levels in hemoglobin and serum bilirubin. Thirty of the patients, including the one who died, showed evidence of dehydration as determined by the specific gravity and the presence of albumin and casts in the urine twenty-four to forty-eight hours after the treatment session. The urinary changes occurred simultaneously with a rise in serum bilirubin and a decrease in the hemoglobin. The urinary changes disappeared in an average of five to ten days. The serum bilirubin returned to the pretreatment status in an average of five to thirty days. Evidence of clinical icterus in the scleras, skin and mucous membranes was proportionate to the rise in serum bilirubin, usually being noted when the level was above 1 or 2 mg. per hundred cubic centimeters. The majority of the patients were ready to leave the hospital in five to seven days after treatment but were retained for collection of the specimens necessary to complete these data.

We previously made similar laboratory analyses for patients with gonococcal infections resistant to sulfonamide therapy who received eight hours of fever at 106 F. (rectal) combined with sulfonamide compounds. The results were not significant. Therefore, it may be assumed that the rather frequent occurrence of the hepatic and renal changes could be attributed, for the most part, to the administration of arsenic and heavy metals. Enough data have not yet been accumulated to demonstrate what part could be attributed to the arsenical administration during fever therapy and what part to the bismuth preparation given immediately before the treatment session.

Studies are under way at the present time to determine the minimal amount of drugs and artificial fever, which in combination would effect clinical "cure" and serologic reversal. It is not the purpose of this presentation to suggest that the routine described be adopted for the treatment of all patients with early syphilis, but it is our hope that through such studies we will eventually be able to demonstrate that the combined use of artificial fever and chemotherapy in one or more sessions can obviate the necessity of long courses either of chemotherapy or of fever-chemotherapy.

Summary and Conclusions

The clinical and serologic findings for 37 patients with early syphilis treated by one session of fever-chemotherapy are presented.

Quantitative serologic tests are an important prognostic guide in following the results of therapy.

Intensification of fever-chemotherapy as described increases complications during and after the treatment.

A ten hour session of artificially induced fever at 106 F. (rectal) combined with administration of 120 to 240 mg. of mapharsen and 4 grains of bismuth subsalicylate in oil (150 mg. of elemental bismuth) is not recommended at the present time as a routine for the treatment of early syphilis.

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WAVELENGTH ALLOCATION FOR DIATHERMY *

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CHICAGO

High frequency electrical energy generated by short wave and long wave diathermy apparatus is electrically the same as that generated by radio broadcasting apparatus, except that the energy is not controlled to convey intelligence. When the diathermy electrodes are adjusted correctly, at least half, and perhaps more, of the high frequency energy generated is absorbed by the tissues in heating them, but the remainder escapes and is radiated into space. In most instances the energy does not radiate very far, but in other instances, if conditions are right, the signal may be picked up many hundred miles away. Several years ago the amateurs reported a great "radio shadow" which filled the spectrum.¹ It was regarded by some as a sinister force that was loosed on the nation. Some one even suggested that the disturbance was deliberately caused by a foreign country bent on confusion. That diathermy interferes with some communications services is not doubted. The Federal Communications Commission has picked up many diathermy signals on monitoring stations. It is more of a potential interference problem than a major one at the present time because communications services have avoided the diathermy frequencies. Now the available radio channels are becoming scarce and more space is asked for to accommodate additional services.

There are two known ways to solve the problem: (1) by screening and (2) by confining diathermy to definite frequencies. Both are more expensive to the physician than the purchasing of simple self-excited oscillators of the prewar vintage. Screening involves the complete metallic lining of the treatment room and the filtering of the alternating current supply circuit. The walls, ceilings and floors may be covered with a copper screen, making a metallic shell. The covering can be installed at an estimated cost of \$10 to \$12 per square yard of floor space. Although this crude installation will work, it is unlikely that physicians will be willing to treat their patients in the resulting unattractive room. Additional expense will be necessary for decorating the treatment room after screening to bring it in keeping with the good taste of the physician's suite of rooms. Screened rooms containing the diathermy apparatus cannot be moved from place to place. It is impractical commercially to screen an entire hospital.

With all short wave diathermy apparatus on assigned wavelengths the mobility problem is solved. In this case, too, the apparatus will be more expensive than prewar apparatus. Further, the more restricted, or narrower, the band, the higher the price.

The Federal Communications Commission has just completed what is believed to be the most extensive survey of the service population of the radio spectrum. Throughout the month of October, 1944 the commission considered, in formal hearings, future needs in the spectrum from the 30,000 meter wavelength to the 1 cm. wavelength, which correspond to 10,000 cycles and 30,000 million cycles. This space embraces practically all services, both in the present and in the immediate foreseeable future.

Aside from the public benefit he receives, the physician practicing physi-

1. Short Wave Diathermy: "The Shadow," editorial, J. A. M. A. 106:1094 (March 28) 1936.

cal medicine is interested in the outcome of the deliberations of the commission with regard to the following points: first, future use of diathermy in his practice; second, length of time the present equipment may be used before it is banned; third, cost of the future apparatus, and, last but not least, the public relations problem. A great deal of study has been done by both the manufacturers and the specialists in physical medicine. It is believed that in the not too distant future a binding allocation of the spectrum to govern the industry for the next five years or more will be announced by the commission.

Former Chairman Fly of the Federal Communications Commission proposed that the men most interested in the field (those in industry and the technical societies) assist the commission. Hence the Radio Technical Planning Board was established, consisting of thirteen panels, each representing a different group of services, for example, standard broadcast, short wave television and radio telegraphy. This board was organized under the able direction of Dr. W. R. G. Baker, and whenever possible it selected the witnesses and arranged the order of presentation. The commission was always in the driver's seat, permitting independent witnesses to appear as well as keeping on hand an ample supply of its own witnesses. The American Medical Association, the American Congress of Physical Medicine and the American Hospital Association sent representatives.

The inquiry was exhaustive, making up, probably, a transcript of a million words long. The setting up of the planning board was a good move because it brought together scientific bodies inside and outside the industry, as well as engineers, scientific advisers and commercial groups. It permitted representatives of the various services to work with one another and share their problems, thus providing avenues whereby they might learn to have more respect for one another's opinions—a vital point, because diathermy is an irritation to the communications interests notwithstanding its therapeutic value.

Panel 12 was assigned the industrial heating, medical and scientific applications. After considerable deliberation by subcommittees representing each of the three fields, suggestions were made that bands be allocated in various portions of the entire spectrum. The medical profession, of course, is most interested in the bands suggested for medical purposes. These bands centered around frequencies of 13.6, 27.3 and 40.9 megacycles or, in other words, wavelengths of 21.95, 10.98 and 7.32 meters, respectively.

Since none of the services included in Panel 12 are radio services per se, there remains a legal question as to whether the Communications Act covers them. Admittedly there may be a legal angle; most persons believe that there is no point in pressing the case, because a law could be passed to give the commission the necessary authority.

The electromagnetic spectrum, so far as radio communications are concerned, is parceled out to many services, of which some are familiar to the medical profession and others are not. For example, the standard broadcast band lies between 550 and 1,600 kilocycles and short wave broadcast bands at various intervals from 10 to 30 megacycles, while television frequencies about 42 to 108 megacycles. Other services are interspaced, such as relay systems, new types of mobile radio communication equipment for buses, railroads, taxicabs and even private citizens. There are bands for amateurs, international broadcasts and frequency modulation broadcasts and for facsimile, education, police and public utilities services.

In the early days, some thirty or forty years ago, one did not need a license to set up a wireless station. Amateurs installed a set and began to send messages. When commercial broadcast stations became a public service the independent broadcasters and amateurs were herded into specific bands so that there would be less interference. This was something like the situation in which the early western cattle herders found themselves when they were required to confine their cattle on specific territory because some of the settlers used barbed wire fence.

It has been said that diathermy was there first and hence should be given the right to the space in the electromagnetic spectrum it has enjoyed. More careful study reveals a public relations problem as well as a public health problem.

Although the medical profession has been brought up to think in terms of wavelengths, the Federal Communications Commission and the communications interests think in terms of frequency—in megacycles and kilocycles. A 20 meter wavelength corresponds to a 13 megacycle frequency, 10 meters to 27 megacycles and 6 meters to 40 megacycles.

To visualize the tremendous job which has been delegated to the Federal Communications Commission for this country and to the International Radio Advisory Committee (a subcommittee of the Department of State to deal with international treaties) for the world, it might be well to look at it in another light. An analogy is a distinct aid in understanding a new problem, but if one takes it too literally it may be misleading and indeed give a false impression.

Assume that the entire continent of North America from the Mexican border to the Arctic Circle is surveyed east and west and laid out with single track railways, together with their drainage ditches, about 200 feet apart. There will then be nothing but right-of-ways straight across the country, all parallel and adjacent to one another. For instance, from Mexico to Minnesota there will be about 10,000 right-of-ways, or channels of communication. Assume still further that trains go only in one direction and at a constant speed. Transportation from the east to the west will be unobstructed; there will be no chance of a collision; there will be no traffic interference. Assume now that the lower frequencies are at the southern extremity of the continent and the higher frequencies at the northern reaches. In the vicinity of Missouri, for example, all tracks may be reserved for freight traffic and in Iowa all right-of-ways for passenger trains. Any enterprising railroad magnate desiring to lay tracks for north and south traffic would be running a chance of snarling the free flow of east and west traffic. This is what diathermy does to the now fixed and allocated communication channels. It sweeps across the channels and interferes with communications.

Following the same analogy, one may consider the right-of-ways in Canada. This space will be analogous to the high frequency channels. Short wave diathermy, which radiates energy, has been operating without serious interference to communications in these high frequencies. In other words, diathermy has been occupying a space in the radio spectrum corresponding in size to the Northwest Territory in Canada. It is true that the amateurs and other experimental services have been in this region scouting out the possibilities of exploiting it, but on the whole diathermy in the early days had it pretty much its own way. The technic of radio manufacturing has now advanced, and the communications interests have found "gold in them thar hills," just as the mineral deposits are being ex-

ploited in northern Canada. Now the "Diathermy Indians" have to be rounded up and put on reservations—that is, assigned to channels or bands definitely set aside for diathermy and heating services.

Promoters of frequency modulation broadcasting and television which are new services, are asking for additional space and these higher frequencies are earmarked for the purpose. Television, it is said, is being inhibited in its development by diathermy and other interfering radiations. The received picture is frequently made indiscernible by mosaic shadows cast on the screen. This is analogous to trains getting crosswise of the parallel tracks and interfering with transportation. Since one diathermy apparatus will not interfere with another and there is no reduction of their efficiency, all diathermy apparatus can be assigned to two or three wavelengths. To go on with the analogy, three right-of-ways might be reserved for trains that can run on the same tracks and bump into one another as much as they like without doing any harm, since they carry no traffic.

Now comes the problem which confronts the Federal Communications Commission so far as diathermy is concerned. What are the relative merits? Is the low cost of diathermy apparatus more important to the welfare of the nation, or should television and frequency modulation for broadcasting entertainment, education and communications purposes be promoted? The Federal Communications Commission already has recognized the importance of diathermy in the medical field and is planning to make room for it. But how much? During the war, medical diathermy apparatus has been developed which will operate efficiently on one channel width, the same tolerance as that of a broadcasting station. The joker is that the apparatus costs more, possibly two or three times as much as comparable equipment of prewar days. The reason, according to the manufacturers, is that additional equipment must be incorporated, including extra tubes, frequency-regulating gadgets, resistors and safety devices. Although the cost of these attachments is not great, experience has shown that for each tube, condenser or other accessory which is added the chances of trouble and breakdowns are increased and thus service and guarantee charges mount. More labor is needed to build the equipment and adjust it and more service men to keep it in repair. Another reason for increase in cost is the diminishing returns on quantity production. As the manufacturer's price goes up so does the retail price, and because this price is higher less equipment is purchased.

In general, the physician is not much concerned with the mechanical construction of the apparatus, its wavelength or its electrical hook-up as he is with its ability to heat tissues, its reserve power, its safety in use and its cost.

The Federal Communications Commission, being pressed by the communications interests, who are asking for more and more space, is obliged to do what it can to satisfy all interests. The argument pushed by the communications groups is to restrict diathermy and industrial heating apparatus to relatively narrow channels as compared with those which they have been enjoying in the past years.

Panel 12 of the Radio Technical Planning Board made recommendations as shown in the accompanying table.

Recommendations by Panel 12 of the Radio Technical Planning Board.

Application	Dominant Frequency Kc./Sec.	Wavelength in Meters	Band Width	
			Per Cent	Frequency Limits, Kc.
Shortwave diathermy— electric field application.....	40,980	7.32	±0.5%	41,185 to 40,775
Shortwave diathermy— both induction and electric field application	27,320	10.98	±7% (±2mc)	29,320 to 25,320
Shortwave diathermy— induction application	13,660	21.95	±0.1%	13,674 to 13,646

* At the hearing a wider space was asked for at the 16 megacycle band—approximately plus or minus 1 per cent. The aforementioned requests on all bands represent a space which might be used by approximately one hundred and ninety communications channels. Some of these channels are not as desirable for communications as others.

Since high frequency electrical energy used in the practice of surgery is generated for the most part by the spark gap oscillator, the band is wide, extending from approximately 500,000 to 4,000,000 cycles per second. The field strength is not excessively high in any specific frequency. Surgical diathermy apparatus is used intermittently and does not operate for long intervals. The energy radiated is extremely small, since most of it is absorbed in the tissues. No formal complaints of interference from these devices have been presented, and therefore it is considered inadvisable to place any restrictions as to frequency stability for electro-surgical generators.

The middle frequency (27.3 mc.) is unique. Communications specialists report that it is not the most desired communications channel because it cannot be depended on. Usually energy in this band will not radiate farther than horizontal distances. This would make the band satisfactory for city police and fire departments, buses, taxicabs and other mobile services of cities with a radius of 10 to 15 miles were it not for the fact that at certain times signals are received many miles away. The phenomenon is believed to be associated with the sunspot cycle. If the demand is great and no other spaces are available, there is a possibility that this band will be used for communications. It can be employed for diathermy and industrial heating. From a therapeutic point of view it is as effective as any other. That it will heat the tissues is not questioned.² It has been exploited as a compromise wavelength for the pads, the coil and the air-spaced electrodes. The drawback is that from a mechanical and electrical point of view it is not as satisfactory for any one of the aforementioned application technics. The coil, for example, works best on the 16 megacycle band and the air-spaced electrodes on the 40 megacycle band. Panel 12 asked for a wider space in the spectrum at middle frequency. If a wider space is allocated on the 27 megacycle band it may be possible for manufacturers to build cheaper equipment (self-excited oscillators working on this wavelength). One thing is certain, that the old frontier in diathermy as enjoyed before

². Coulter, John S., and Carter, Howard A.: Heating of Human Tissues by Short Wave Diathermy, J. A. M. A. 106:2063 (June 13) 1936.

the war is gone and more expensive equipment will be unavoidable in the future.

The Federal Communications Commission has been requested to allow physicians five to ten years in which to liquidate their present investment in short wave diathermy equipment.

Author's Note — Since writing the manuscript for this article, the Federal Communications Commission has issued a report of proposed allocations from 25 megacycles to 30,000 megacycles. In this report the Commission proposes to allocate for use of the industrial and medical service three bands having a center frequency of 13.66 megacycles, 27.32 megacycles and 40.98 megacycles, with a proposed band width of $\pm 0.05\%$ in each case.

These bands are equivalent to approximately one channel for radio communications. Diathermy apparatus to operate on this tolerance will have to be crystal controlled. The apparatus will undoubtedly cost more than prewar equipment. Whether this will raise the general cost of medicine is problematical.

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CANCELLATION OF EASTERN SECTIONAL MEETING

At the urgent request of the War Committee on Conventions and in accordance with the plea of the Director of War Mobilization and Reconversion, James F. Byrnes, it has been deemed necessary to cancel the Eastern Sectional Meeting of the Congress scheduled to meet April 14, 1945, at the University of Pennsylvania Hospital, Philadelphia.

THE STATUS OF REFRIGERATION FOR MILITARY SURGERY

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The advantages of surgical refrigeration, first indicated by animal experiments,¹ were demonstrated clinically on a large scale by Crossman and associates² at the City Hospital, New York, beginning in 1941, and have been confirmed by a large number of subsequent writers in this country and in several foreign countries. These advantages may be summarized as the avoidance of operative shock, which is particularly important in poor risk patients; control of infection and intoxication; freedom from postoperative pain and edema; reduction of local tissue metabolism so as to bring the needs within the capacity of the impaired blood supply, thus preventing sloughing and favoring primary union; preservation of poorly vitalized tissues and blood vessels, which together with direct inhibition of clotting minimizes the dangers of thrombosis and embolism, and, in total, an improvement in local and constitutional conditions which has strikingly reduced the death rate from amputations in our own experience and in that of many independent observers.

While a tourniquet is used for brief refrigeration anesthesia, several highly important therapeutic uses have been developed for more prolonged reductions of temperature without a tourniquet. Thus it was shown by McElvenny³ that pain, shock and infection can be arrested by packing mangled wounds with ice; by Mock⁴ that thrombosed legs can be kept from gangrene for two or two and one-half weeks, and by Crossman⁵ and others that embolism and various infections can be similarly held in abeyance. Hypothermia has become established as a standard treatment for frostbite, immersion foot and other injuries due to cold, thanks to work done in Canada and England.⁶ Both local and constitutional hypothermia are an important help in treatment of shock.⁷ I have tried vainly to obtain adequate trials of a radi-

1. Allen, F. M.: (a) Local Asphyxia and Temperature Changes in Relation to Gangrene and Other Surgical Problems, *Tr. A. Am. Physicians* 52:189, 1937; (b) Reduced Temperatures in Surgery: I. Surgery of Limbs, *Am. J. Surg.* 52:225 (May) 1941.

2. Crossman, L. W.; Ruggiero, W. F.; Hurley, V., and Allen, F. M.: Amputations for Patients for Peripheral Vascular Disease, *Arch. Surg.* 44:129 (Jan.) 1942. Crossman, L. W.; Allen, F. M.; Hurley, V.; Ruggiero, W. F., and Warden, C. R.: Refrigeration Anesthesia, *Anesth. & Analg.* 22:264 (Sept.-Oct.) 1943.

3. McElvenny, R. T.: The Effect of Cooling Traumatized and Potentially Infected Limbs, *Surg., Gynec. & Obst.* 73:263 (Aug.) 1941. The Present Status of Cooling Limbs, in Preparation for Surgical Procedures, *Am. J. Surg.* 58:110 (Oct.) 1942. Recent Evolution of Cold as an Adjunct to Surgery, *Arch. Phys. Therapy* 25:599 (Oct.) 1944.

4. Mock, H. E., and Mock, H. E., Jr.: Refrigeration Anesthesia in Amputations, *J. A. M. A.* 123: 13 (Sept. 4) 1943. Mock, H. E., and Tannehill, E. H.: Fractured Pelvis Complicated by Gangrene of Extremity. Amputation Under Refrigeration Anesthesia, *Surg., Gynec. & Obst.* 78:429 (April) 1944.

5. Crossman, L. W., and Hurley, V.: Embolism of the Femoral Artery. A Case Report, *J. Internat. Coll. Surgeons* 5:171 (March-April) 1942. Crossman, L. W.: Refrigeration for the Preservation of Traumatized Tissues, *Canad. Hosp. J.* 21: (Aug.) 1944. (Also forthcoming in *J. Internat. Coll. Surgeons*.)

6. Webster, D. R.; Woolhouse, F. M., and Johnston, J. L.: Immersion Foot, *J. Bone & Joint Surg.* 24:784 (Oct.) 1942. White, J. C.: Vascular and Neurologic Lesions in Survivors of Shipwreck, *New England J. Med.* 228:211 (Feb. 18) and 241 (Feb. 25) 1943. Bigelow, W. G.: The Modern Conception and Treatment of Frostbite, *Canad. M. A. J.* 47:529 (Dec.) 1942. Greene, R.: Cold in Treatment of Damage Due to Cold, *Lancet* 2:1695 (Dec. 12) 1942. Ungley C. C.: Treatment of Immersion Foot by Dry Cooling, *ibid.* 1:681 (May 29) 1943.

7. (a) Allen, F. M.: Reduced Temperature in Shock Treatment, *Am. J. Surg.* 60:335 (June) 1943; (b) Theoretical and Experimental Aspects of Surgical Refrigeration, *Canad. M. A. J.* 51:220, 1944; (c) Treatment of Surgical Shock and Embolism, *J. Internat. Coll. Surgeons* 7:423 (Nov.-Dec.) 1944; (d) Cleghorn, R. A.: The Effect of Different Environmental Temperatures on the Survival of Dogs After Severe Bleeding, *Canad. M. A. J.* 49:363 (Nov.) 1943; (e) Elman, R.; Cox, W. M.; Lischer, C., and Mueller, A. J.: Mortality in Severe Experimental Burns as Affected by Environmental Temperature, *Proc. Soc. Exp. Biol. & Med.* 51:350 (Dec.) 1942; (f) Devine, J.: Temperature in Shock, *M. J. Australia* 2: 476 (Dec. 11) 1943; (g) Fay, T.: Cooling in Shock, *J. A. M. A.* 121:1109 (March 27) 1943; (h) Green, H. D.: Traumatic Ischemic Shock. With Observations on Effects of Environmental Temperature, Paper, Section on Pathology and Physiology, *Am. Med. A.*, June 14, 1944.

cally new proposal for treating burns,^{7b} namely, that the customary cleansing and debridement be omitted absolutely, as destructive of injured tissues; that the area be covered with thin gauze impregnated with petrolatum or a bacteriostatic ointment; that cold applicators outside of this control pain, shock, infection and intoxication. The wound cleanses itself automatically in the daily changes of dressings; both constitutional danger and local tissue loss are thus prevented to an unprecedented degree. The few clinical trials⁸ have been extremely encouraging.

The reception of refrigeration by the general medical profession was so remarkably favorable that the method has not been condemned by a single writer who has tried it. Our group and probably most workers do not agree with the limitations to its use suggested by Neller and Schmidt,⁹ or with the impression of tissue injury gained by Richards¹⁰ from one or two complicated cases. In a circular letter from the office of the Surgeon General of the Army under date of Jan. 15, 1943 refrigeration was included as one of twenty-seven principal medical advances for 1942. Nevertheless, during four years of war, in which were involved many thousands of casualties for which refrigeration is demonstrably beneficial or life saving, and during which a number of military and naval officers¹¹ proved the feasibility and desirability of the method, it has been impossible to obtain any interest or action on the part of the responsible subcommittees of the Committee on Medical Research, with a view to adoption of, instruction for or provision of facilities for the method. Finally, in the November issue of the *Annals of Surgery* there appeared a group of four papers¹² attacking the elementary basis of the refrigeration method. This work was financed by the Committee on Surgery and carried out in the department of surgery headed by the chairman of this committee. Being thus backed by the prestige of the committee and of Washington University, the stated conclusion that refrigeration should not be adopted for military use will obviously block such adoption as long as it stands unrefuted. Therefore, at a time when thousands of military casualties are occurring week by week, it is an urgent duty to expose these errors at the earliest possible moment and in the fullest detail.

The first of the four papers, by Large and Heinbecker, describes 6 patients in whom severe intoxication due to infected gangrene of a foot was "dramatically" arrested by refrigeration below the knee. Subsequently amputation was performed above the knee with the patient under general or spinal anesthesia. Allegedly, "none of the patients suffered from shock during or after the operation." Refrigeration anesthesia was avoided because "it is felt preferable that all refrigerated tissue should be removed at operation." This was the only clinical experience reported, and the prejudice against refrigeration was based on an interpretation of the animal experiments described later. Because the animal tissues were supposedly harmed somewhat by forty-eight to ninety-six hours of continuous cold, it was reasoned that refrigeration anesthesia for two or three hours must be dangerous. Since these authors preferred general or spinal anesthesia, they

8. (a) Allen, F. M.; Crossman, L. W., and Safford, F. K.: Reduced Temperature Treatment for Burns and Frost-Bite, *New York State J. Med.* 43:951 (May 15) 1943. (b) Safford, F. K., and Nathanson, M. B.: Clinical Observations on Tissue Temperatures, (Reprint, with additions). *Arch. Surg.* 49:12 (July) 1944. Allen, F. M.: *Am. J. Surg.* (to be published).

9. Neller, J. L., and Schmidt, E. R.: Refrigeration Amputation, *Wisconsin M. J.* 43:936, 1944.

10. Richards, V.: Refrigeration Anesthesia in Surgery, *Ann. Surg.* 119:178 (Feb.) 1944.

11. (a) Bowers, W. F.: Refrigeration Therapy in Vascular Trauma, *Mil. Surgeon* 93:289 (Sept.) 1943. (b) Ottaway, J. P., and Foote, J. F.: Refrigeration of Wounded Extremities, *U. S. Nav. Med. Bull.* 43:1041 (Nov.) 1944.

12. Large, A., and Heinbecker, P.: Refrigeration in Clinical Surgery, *Ann. Surg.* 120:707 (Nov.) 1944. Bruneau, J., and Heinbecker, P.: Effects of Cooling on Experimentally Infected Tissues, *ibid.* 120:716 (Nov.) 1944. Large, A., and Heinbecker, P.: The Effects of Cooling on Wound Healing, *ibid.* 120:727 (Nov.) 1944. Nerve Degeneration Following Prolonged Cooling of an Extremity, *ibid.* 120:742 (Nov.) 1944.

should argue likewise that unless this anesthesia can be maintained continuously for forty-eight to ninety-six hours it must not be used for two or three hours. The principal points to be noted are, first, that the reported control of intoxication is nothing new but is the same as has been obtained by Crossman,¹³ McElvenny,³ Smith,¹⁴ Haley,¹⁵ Miyakawa¹⁶ and others; second, that these authors condemned refrigeration for either civil or military surgery without a single experience with it for either operation or therapeutic preservation and in contradiction of all the large literature of actual clinical observations.

It is notable that these authors also have had no experience whatever with brief refrigeration in animal experiments. In regard to hypothermia of longer duration, such as that used not for operations but for some therapeutic purposes, they were influenced by an interpretation of the work of Brooks and Duncan,¹⁷ whose accuracy they emphasized, apparently in invidious comparison with my prior demonstration of the preservation of animals' legs by cold. As I have previously pointed out, the accuracy of Brooks and Duncan was as follows: In 1940 they formally demonstrated a fact which had long been known, namely, that pressure injures tissues. Inserting rats' tails in a plethysmograph type of apparatus, they showed that a pressure of 130 mm. of mercury for eighteen hours caused massive necrosis, a pressure of 120 mm. for seventeen hours converted the tail into scar tissue and pressures of 70 mm. or over for fourteen to sixteen hours caused very marked sclerosing myositis. Their second paper described refrigeration of rats' tails in the same type of apparatus at a pressure of 130 mm. for periods up to ninety-six hours, and a slight fibrosis which developed in the well preserved tissues after the longest experiments was attributed to cold by them and by all superficial readers since then. All that is yet known, experimentally or clinically, is that cold powerfully reduces but does not entirely prevent the injury caused by pressure; also that no fibrosis has resulted from much longer ice box storage of tissues. The time limits of safe preservation and the gradual changes that must occur when these limits are exceeded is a still open question, which I long wished to investigate adequately but was prevented from so investigating by the monopoly of funds and facilities.

The subsequent experiments of Brooks and Duncan, published in 1941, carry the implication that I was unintelligent enough to recommend chilling simple minor wounds to ice temperature for twenty-four to forty-eight hours. As everybody who has taken the trouble to read my publications knows, I have never had an idea of improving on natural processes when these are adequate.¹⁸ Aside from avoidance of operative shock, reduced temperature

13. Crossman and associates, footnotes 2 and 5.

14. Smith, W. E.: Refrigeration of Gangrenous Extremities Before Amputation, *Ohio State M. J.* 38:826 (Sept.) 1942.

15. Haley, E. R.: Arteriosclerotic Gangrene; A Report on Refrigeration Prior to Amputation, *Arch. Surg.* 40:518 (April) 1943.

16. Miyakawa, G.: Refrigeration Anesthesia. With Special Reference to Treatment of a Severely Damaged Extremity Complicated by Visceral Injury, *Am. J. Surg.* 66:384, 1944.

17. Brooks, B., and Duncan, G. W.: Effects of Pressure on Tissues, *Arch. Surg.* 40:696 (April) 1940. The Effects of Temperature on the Survival of Anemic Tissue, *Ann. Surg.* 112:130 (July) 1940. The Influence of Temperature on Wounds, *ibid.* 114:1069 (Dec.) 1941.

18. As for limitations and dangers in the normal organism, several years prior to Brooks and Duncan I published experiments [Allen, F. M.: Experiments Concerning Ligation and Refrigeration in Relation to Local Intoxication and Infection, *Surg., Gynec. & Obst.* 68:1047 (June) 1939], to which they never referred, showing that badly infected legs of animals or patients could be refrigerated with a tourniquet for two to five hours with negligible or slight harm, but the infected legs of animals could not be safely preserved like normal limbs for twenty-four to forty-eight hours, because diffusion of toxins during the chilling resulted in gangrene after rewarming. Also, it was shown that simple chilling of the peritoneum could lower its resistance to infection, a result that has never been found in limbs. Likewise, instead of using a drop of turpentine I performed experiments with the more practical and more powerful injection of snake venom [Allen, F. M.: Mechanical Treatment of Venomous Bites and Wounds, *South. M. J.* 31:1248 (Dec.) 1938; Observations on Local Measures in the Treatment of Snake Bite, *Am. J. Trop. Med.* 19:393 (July) 1939], showing that although its action is inhibited by cold it diffuses widely through the chilled tissues so that they become necrotic after rewarming. Brooks and Duncan's experiments seem to carry no different significance.

has been proposed to meet two plainly stated conditions. One was a condition of inadequate circulation due to arteriosclerosis or other causes, and the low temperature was intended to control excessive inflammation and slow the healing process so that the reduced local metabolic needs would be brought within the capacity of the limited blood supply. The other condition was an overwhelming local infection, which might be held temporarily in abeyance until recovery of strength along with surgical and medical treatments might create a basis for recovery. The two conditions may be combined, as when the improved nutrition and oxygenation of arteriosclerotic limbs increases their resistance to infection. The only reasons for refrigeration in amputation of normally nourished limbs are, first, the belief that no patient should intentionally be subjected to shock merely because he is strong enough not to die from it and, second, the helpful control of the pain and edema of a violent inflammation. All informed persons know that the usual method consists in a brief radical refrigeration at the critical time, followed by application of intelligently selected temperatures somewhat above or below 60 F.

The second *Annals of Surgery* paper, by Bruneau and Heinbecker, dealt with small injections of staphylococci subcutaneously or into wrist joints of dogs, the limbs being immersed in water at 6 C. for twenty-four to ninety-six hours. The bacterial counts at the end of refrigeration were practically identical with the number injected, indicating complete bacteriostasis at both superficial and deep tissue levels. In the untreated dogs the bacteria steadily diminished, the dose being easily within the normal resisting power. After forty-eight hours of refrigeration, followed by forty-eight hours at normal temperature, the condition was practically identical with that in untreated animals forty-eight hours after inoculation. After ninety-six hours of refrigeration the subsequent infection was slightly greater than in the controls, but there were no dangerous consequences either under the skin or in the joints. Since the refrigerated limbs were subjected to the combined effects of immobilization, dependent position and soaking in water, while the control animals were left free, the results were favorable beyond anything that I personally could have dared to hope. They prove definitely that an infection can be held absolutely in abeyance at a cost of little or no local tissue injury, even under more harmful conditions than would ever be conceived of therapeutically. Furthermore, these authors themselves noted that the diminishing number of cocci in their untreated controls was presumably due partly to a carrying away through the lymphatics. The absence of such transportation is extremely important in the class of infections which need treatment refrigeration. These authors may be interested in other experimental literature on this point; for example, the report on animal experiments of the Muschenheim-Stoll group,¹⁹ showing that the local reaction to intracutaneously injected pneumococci is abolished by cold. With lowering of the general body temperature a fatal bacteremia results, but with simple local refrigeration there is no systemic invasion. Likewise, the authors do not know or intentionally omitted the clinical literature, which uniformly disproves their assumption that tissues of subnormal vitality will suffer more severely from cold, and proves the precise opposite.

The third paper of the series compared the healing of skin incisions in the forelegs of dogs under identical conditions except that one of each pair of legs was refrigerated, with rubber protection against wetting, for periods of twenty-four or forty-eight hours. The results showed delayed healing

19. Muschenheim, C.; Duerschner, D. R.; Hardy, J. D., and Stoll, A. M.: Hypothermia in Experimental Infections: III. The Effect of Hypothermia on Resistance to Experimental Pneumococcus Infection, *J. Infect. Dis.* 72:187, (May-June) 1943.

and slightly greater infection in the chilled legs. In view of the remarkable universality of bacteria in normal dog tissues, revealed by work of the groups represented by Aub and Prinzmetal, it appears that delayed healing must be synonymous with a rubbing of more organisms into the wound under the confined conditions of laboratory animals, which conditions do not prevail in the case of human patients. Also it seems reasonable that a dog may struggle less with the leg that feels sore than with the one that is anesthetized by cold. The essential facts, however, are, first, that these authors duplicated the errors of Brooks and Duncan in selecting trivial wounds of normal tissues instead of the conditions of arteriosclerosis, etc., for which refrigeration was intended; second, that they confirmed the fact of delayed healing, which was known to us years ago when we advised delay in the removal of skin sutures on this account. It is astonishing that expensive experimentation should have been based on an assumption that some one had been idiotic enough to propose retarding the healing of simple minor wounds for which ample circulation and resistance exist. These authors ignored our emphasis on thermal control of local metabolism and rate of healing as a means of preventing the formerly frequent sloughing of flaps, our published photograph^{1b} of an 84 year old patient with primary healing after an amputation below the knee, our description of other cases² in which we intentionally amputated in "forbidden" areas as low as the ankle and also the testimony of the numerous surgeons who have confirmed our claims of improved healing in such malnourished limbs. If clinical evidence is scorned, why should there be no reference to other experimental work, notably that of Blakemore, Lord and Stefko?²⁰ This involved cutting off the legs of dogs completely, refrigerating them for twenty-four hours and then restoring them to their former position and function. Blakemore and co-workers correctly emphasized that the difficulties of such a procedure are far greater in dogs than in man. They restored circulation by foreign bodies, namely, cannulas, left permanently in the blood vessels. The absence of thrombosis and the completion of healing under these conditions provided the most positive demonstration of the exquisite preservation of entire limbs by refrigeration for twenty-four hours, and there is no knowledge as to how much longer the time limit might be. This, together with our own published and unpublished observations, must be called to the attention of Richards and all others who imagine that a couple of hours of surgical refrigeration dangerously damages limb tissues.

The fourth paper from the surgical department of Washington University deals with nerve degenerations resulting from immersion of dogs' legs in water at 6 C. for periods up to ninety-six hours. Such experiments for reproducing trench or immersion foot were new about 1915, and the proof by subsequent investigators that the primary or dominant injury is vascular rather than nervous is not altered by these late experiments and is immaterial to the present discussion. The essential facts are two. First, the methods used here for the intentional purpose of producing trench foot, namely, immobilization, dependency and soaking in ice water, are identical with the methods used in the experiments reported in the second paper, which purported to be a fair study of the influence of cold on infection. Second, even under these grossly injurious conditions maintained as long as ninety-six hours with methods which would be unthinkable for clinical therapy, the damage was transitory or microscopic. The limbs regained motion, sensation and function, and there was no hint of crippling or need of amputation in any of the 20 dogs.

20. Blakemore, A. H.; Lord, J. W., and Stefko, P. L.: Restoration of Blood Flow in Damaged Arteries, *Ann. Surg.* 117:481 (April) 1943.

This is the experimental evidence on which these authors, who have never done an amputation under refrigeration, who have not a single experience of prolonged hypothermic therapy, insist that all tissue that has been chilled even briefly must be excised, and particularly condemn refrigeration for the military services. Furthermore, as regards their "feeling" that tissues of impaired vitality must be harmed more by cold than normal tissues, did they pay any attention to Mock's reports⁴ of patients received several days after complete femoral thrombosis? After treatment of their dangerously devitalized limbs by refrigeration for two or two and one-half weeks, amputation was performed far below the level of refrigeration, and Mock, who should be a competent judge, considered that the preservation of tissue had allowed time for collateral circulation and permitted saving a greater part of the limb than usual. Should any notice have been taken of the report by Colonel Bowers^{11a} that soldiers' legs which had begun to turn black became restored in color and vitality under refrigeration? or of Crossman's collection⁵ of still more impressive records? or of Fay's lodgment of an applicator at 40 F. in the human brain for one hundred and thirty-three days without harm? Why neglect the case of Kross, published by Safford and Nathanson,^{8b} in which a woman's burned and infected leg was chilled for eleven weeks, the longest hypothermic therapy of a limb on record? Under former treatments she would have died from acute intoxication. When the fever and the toxic danger had been rapidly controlled by refrigeration, nobody in the group of observers expected anything better than an amputation after a short period of strengthening. The ultimate outcome was saving of the limb except three toes. The treatment was guided rationally. For the immediate toxic crisis, radical refrigeration was used during the first couple of days. To permit of gradual and retarded healing, the temperatures were later raised to the neighborhood of 60 F. The influence was definite, because whenever the hypothermia was omitted the fever rose so as to compel resumption of the treatment. Use of sulfonamide compounds and penicillin and all other special measures were intentionally avoided, to make an objection-free demonstration. The entire four papers in the annals of Surgery show one peculiarity; namely, references are limited to a few scraps which seem capable of adverse interpretation, and the overwhelming mass of demonstrations in support of refrigeration receive not a single mention.

In contrast to this condemnation by authors without any experience is the Russian endorsement by Yudin,²¹ on the basis of 120 amputations with refrigeration anesthesia. Prevention of shock, improved primary union and reduction of wound infection and mortality were demonstrated. Refrigeration for military surgery "is highly recommended for use at the front as well as the rear." Further publications in prospect include reports on advanced research, such as the prevention of absorption of lethal quantities of mustard gas in animal experiments. Another Russian confirmation²² is based on animal experiments and 100 clinical amputations.

I have previously pointed out that the opposition, which caused years of delay and prevented refrigeration from being ready and tested before the outbreak of war, was responsible for vast needless suffering in operations without anesthetics during the first winter campaigns in the more primitive countries from Finland to China. The subsequent and continuing results are seen in the undeniable fact that thousands of injuries such as those described by McElvenny, Mock, Bowers, Crossman and others are inevitable in war

21. Yudin, S. S.: Refrigeration Anesthesia for Amputations, *Am. Rev. Soviet Med.* 2:4 (Oct.) 1944.

22. Lobachev, S. V.: *Abst. J. A. M. A.* 127:300, 1945.

and entail loss of life or limb without refrigeration. An apparent example of this neglect in the death of a war correspondent happened to reach the public press.⁷⁰ No official heed has ever been given to unpublished reports from private surgeons and from individual medical officers concerning severe wounds or gas gangrene infections which the attendants considered would have been fatal except for the radical arrest of bacterial invasion and toxic absorption, which was one of the purposes for which refrigeration was originally designed. Trivial excuses, such as lack of ice at the fighting fronts, are inconsistent with the boasts of bulky equipment provided very near the front, the extremely rapid transportation of wounded to hospitals and the known supply of ice on ships and even in canteens at many isolated posts. A recent letter from the Southwest Pacific from a former member of our group mentioned results in a case of multiple compound fractures of both legs in which refrigeration was employed by means of ice obtained from a Liberty ship in the harbor. While machines weighing one to several tons have been widely distributed through the tropics for the icing of food and drinks, no official instructions have been given for the use of refrigeration when it is available, and not a single test has been made of the special refrigerating apparatus which can be provided in a portable form, weighing only 200 pounds, and which provides the best means of treating burns and a variety of other injuries. As regards research, the hypothermic treatment which saves the frostbitten limbs of shipwrecked sailors would never have been tried if the work had not been done in Canada and England, and our urging of refrigeration as offering unprecedented benefits for burns has not gained even a trial. In the November-December issue of the *Journal of the International College of Surgeons* I have criticized a similar stagnation in the handling of the shock problem. The accomplishments of these Committees have been limited to elaboration of methods already introduced or mapped out by others, and in return for their huge expenditures of public funds they have not produced a single new idea in refrigeration or any other line of shock therapy. The disgrace is climaxed by the adoption of the method in Russia and the quite possible transmission to Germany before our own soldiers obtain the benefit. It becomes necessary to inquire publicly why, in a war crisis which demands rapid decisions, with thousands of men being killed or wounded daily, there should have been these years of avoidance of a trial of refrigeration in any form or for any purpose. The narrowness of scientific domination may sufficiently explain a remark in an editorial of the *Journal of the American Medical Association* for May 1, 1943: "Future generations may find it difficult to understand why it is taking us so many years to appreciate the significance of reduced temperature."

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CURARE *

Its Pharmacology and Its Use as an Adjunct to Convulsive Shock Therapy

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One of the major problems of medicine today is the ever increasing number of persons suffering from mental diseases and requiring hospitalization. Recent advances in treatment by convulsive-irritative therapy through the use of curare as an adjunct offer a glimmer of hope in the solution of this problem.

The history of curare, "the flying death" of Gill,¹ is romantic enough, shrouded in mystery and made up of the humanly interesting accounts of early and late explorers, laboratory workers who have searched for its antidotes and clinicians who are learning to use it for its therapeutic value.

Until recently, the story of curare was essentially the story of the witch doctors and the Indians of northern South America, particularly of the region about the upper part of the Amazon, known as Amazonia. Here curare has been used as an arrow poison since the earliest times.

However, the use of poisoned arrows by the South American Indians is not the first recorded use of such weapons. Ancient classical literature contains many references to arrow poisons. Homer mentioned them in his *Odyssey*, as did Virgil in his *Aeneid*. Apollo's darts carried a "pestilence," and the Biblical writers are concerned with the subject, as is evidenced in the book of Job (6:4): "For the arrows of the Almighty are within me, the poison whereof drinketh up my spirit." This ancient association of bows and arrows with poisons is responsible for our present term for the knowledge of poisons, the word "toxicology" being derived from the Greek word "toxon," meaning bow. The modern term "toxophilite," meaning "a person devoted to archery," is derived from the same source.

The earliest obtainable English reference to curare is found in Sir Walter Raleigh's "large, rich, and beautiful, Empire of Guiana."² In 1595 he described a great plain on the upper reaches of the Orinoco which was inhabited by four tribes of Indians. Writing of them he said:

... the fourth are called Aroras, and are as blacke as Negroes, but have smooth haire, and these are very valiant, or rather desperate people, and have the most strong poyson on their arrowes, and most dangerous of all nations, of which poyson I will speake somewhat being a digression not unnecessary.

There was nothing whereof I was more curious, than to finde out the true remedies of these poysoned arrowes: for besides the mortalitie of the wound they make,

* This work was done by Captain Kuitert, as a student officer under the direction of Dr. F. H. Krusen, while he was on assignment at the Mayo Foundation for instruction in physical medicine.

1. Gill, R. C.: *White Water and Black Magic*, New York, Henry Holt & Company, 1940, p. 369.

2. Raleigh, Walter: "The discoverie of the large, rich, and beautifull Empire of Guiana, with a relation of the great and golden citie of Manoa (which the Spaniards call El Dorado) and the provinces of Emeria, Aromaiia, Amapaia, and other countries, with their rivers adjoyning. Performed in the yeere 1595 by Sir Walter Raleigh Knight, Captaine of Her Majesties Guard, Lorde Warden of the Stanneries, and Her Highnesse Lieutenant Generall of the Countie of Cornewall. In Hakluyt, Richard: *The principal navigations voyages traffiques & discoveries of the English nation; made by sea or over-land to the remote and farthest distant quarters of the earth at any time within the compasse of these 1600 yeeres.*" Glasgow, James MacLehose and Sons, 1904, vol. 10, p. 338-431.

the partie shotte indureth the most insufferable torment in the world, and abideth a most ugly and lamentable death, sometimes dying starke mad, sometimes their bowels breaking out of their bellies: which are presently discoloured as blacke as pitch, and so unsavoury, as no man can endure to cure, or to attend them. And it is more strange to know, that in all this time, there was never Spaniard either by gift or torment that could attaine to the true knowledge of the cure, although they have martyred and put to invented torture I know not how many of them. But every one of these Indians know it not, no, not one among thousands, but their soothsayers and priestes, who doe conceale it, and onely teach it but from the father to the sonne.

According to West,³ Alexander von Humboldt in 1821 was apparently the first to witness the making of curare by one method of manufacture, and it was he who made it clear that there were several different arrowhead poisons in use by the Indians of South America. He recorded that the curare of Esmeralda on the Orinoco was stronger than that used by the Ticuna Indians of the Amazon. His contemporary Sir Robert Schomburgk⁴ apparently is responsible for many of the discussions of zoologists regarding the proper genera of the several jungle plants from which curare is made, because he classed the plants as members of the genus *Strychnos* in 1857. While some of the *Strychnos* curares contain the strychnine type of alkaloids, the convulsant property of these alkaloids usually is masked more or less by the peripheral paralyzing action of other alkaloids.

Chemists soon succeeded in extracting active principles from the forms of curare reaching them, the first such principle thus extracted being curarine, which was obtained as a "syrupy body" by Boussingault and Roulin⁵ in 1828 and prepared in crystalline form by Preyer⁶ in 1865. A second crystalline alkaloid, curine, was recognized and prepared by Boehm⁷ in 1896. Boehm was also the first to obtain a 5 per cent yield of curarine direct from the bark of *Strychnos toxifera*.

The geographic distribution of the various types of curare is extremely interesting. Behind the drug lie the *Strychnos* species of plants of tropical America. There are three known great curare-producing areas: (1) Upper Amazonia, (2) the upper reaches of the Orinoco and (3) the Kanaku Mountains of British Guiana. Into some curare from the first region probably enters *Strychnos castelnaeana*; into that from the second region enters *Strychnos cogens* or *Strychnos gubleri* or both, and into that from the third region enters *Strychnos toxifera*. These *Strychnos* plants are responsible in each case for the paralyzing action of the drug. However, in the Guiana curare additional and different species of *Strychnos* enter the preparation, of which one paralyzes, one convulses and one is primarily a depressant of the central nervous system. Thus whenever several different species of *Strychnos* enter a curare the possibility that one possesses an action other than curariform is to be considered. From only one of these plants has the alkaloid been isolated as yet. That plant is *Strychnos toxifera*, from which curarine has been prepared by Boehm, as already related.

Pharmacology of Curare

The original description of the physiologic effects of curare was written by Claude Bernard⁸ in 1856. Since the time of Bernard curare has been the drug par excellence for laboratory work in blocking nerve impulses between the nerve fiber and the muscle fiber supplied by it. In addition to

3. West, Ranyard: The Pharmacology and Therapeutics of Curare and Its Constituents, Proc. Roy. Soc. Med. 28:565 (Mar.) 1935.

4. Schomburgk, Robert: Quoted by West.³

5. Boussingault and Roulin: Quoted by West.³

6. Preyer, quoted by West.³

7. Boehm, quoted by West.³

8. Bernard, Claude, quoted by Sollmann.¹²

demonstrating that the site of action was the myoneural junction, Bernard showed (1) that the drug must enter the body by some route other than the alimentary tract in order to be effective, (2) that the sensory mechanism is not affected, (3) that the action of the drug does not produce any irreversible change in the muscle or the nerve and (4) that the cardiovascular system is not affected directly by the drug. Pharmacologists soon became aware of the varying properties of the curares. Curares containing *Strychnos* "curare" were described by Couty and de Lacerda⁹ as paralyzing the vasomotor mechanism and thus causing a fall of blood pressure, and the same authors expressed the opinion that *Strychnos triplinervia* is responsible for the convulsions of curare.

In 1890 Tillie¹⁰ demonstrated a convulsant effect of curarine "after-destruction of the anterior brain and exclusion of the legs by vascular ligature." Cash¹¹ in 1901 mentioned having observed this convulsant effect of curarine but added that "two specimens out of three of curare did not show this action" and that "at most curare is but a feeble convulsant and this element of its action is masked by peripheral paralysis." He noted that tonic convulsions have been seen in the dog, and he distinguished such convulsions from "muscular tremor, which is frequently witnessed in curarized animals." The variable composition of the drug has long been known, and it is important to realize that these earlier observers were aware that the varying action of the curare is dependent on the different *Strychnos* plant constituents.

The need for a classification of the "curares" soon became apparent. In 1895 Boehm classified them in groups according to their containers. This classification closely agreed with his chemical analysis of the specimens. He recognized that curare usually leaves the forest regions of its production in one of three kinds of vehicles: (1) a small earthenware pot, (2) a hollowed gourd, or "calabash," or (3) the interior of a bamboo cane. He described three alkaloids as being present in "pot" curare, an additional alkaloid in "calabash" curare and two different additional ones in "bamboo," or "tube," curare. The vehicular classification of curare was considered for a time to distinguish the types geographically, but this conclusion proved later to be incorrect.

Curare is now commonly classified pharmacologically according to the action of the various specimens after the schema of West,³ as follows:

1. Paralysis is a *sine qua non* of curare.
2. Convulsant action closely resembling that of strychnine is produced by some specimens.
3. Some specimens exert a specific respiratory effect or action in which breathing becomes slowed, labored and deliberate, and this stage is followed by complete respiratory paralysis before obvious skeletal muscular weakness and general paralysis occur. This action is observed only in curares which have a convulsant action also.
4. Some specimens produce the "lissive action" of West or the selective removal of pathologic rigidities without apparent diminution of voluntary power, as is seen among dogs suffering from tetany and among human patients suffering from rigidity due to a lesion of the pyramidal or of the extrapyramidal tract. While different specimens of curare vary in composition, this "lissive" property appears in all specimens, classified both by container and geographically.

Authenticated curare is a mixture of watery extracts of a number of poisonous plants. Produced as it is in regions of South America scattered over many thousands of miles of territory, the best criterion which can be

9. Couty and de Lacerda, quoted by West.³

10. Tillie, quoted by Sollmann.¹²

11. Cash, quoted by Sollmann.¹²

established for the crude drug, either by the standards of the Indian hunter or by those of the physiologist, is that it is a powerful poison whose predominant action is the paralysis of voluntary muscles.

Drugs derived from the vegetable kingdom depend for their effect on certain active principles derived from the important chemical groups of plant constituents; namely, proteins, fats, carbohydrates, tannins, resins, alkaloids, glucosides, acids, terpenes and inorganic salts. The active principles of the curares are alkaloids.¹² Of the known alkaloids, curarine and protocurarine have the most typical effects. Wintersteiner and Dutcher,¹³ of the Squibb Institute for Medical Research, have isolated one of the alkaloids in crystalline form and have worked out the chemical composition of the drug, which is expressed in the formula $C_{30}H_{44}O_5N_2Cl_2$. It is a quaternary alk2loid, the action of which is the classic action of curare, that is, a paralysis of the muscles because of a failure of the effective transmission of the impulses to them along the motor nerves. Recent work by McIntyre and King¹⁴ indicates that curare acts on the muscle directly, in small doses preventing it from accepting acetylcholine.

Anatomically the order of sensitivity of muscles is strikingly constant.¹⁵ Paralysis occurs first in the muscles receiving a cranial nerve supply, second in the skeletal muscles, generally including the intercostal muscles, and third in the diaphragm. Sollmann¹² related the order of paralysis as follows:

Short muscles of the toes, ears, and eyes; then, the limbs, head and neck; finally the respiratory muscles, first the thoracic, then the diaphragmatic and lastly the abdominal. The heart is not affected except with very much larger doses. The muscles which are least affected are those which contain the largest amount of utilizable oxygen. These survive longest after the death of the animal. This supply of oxygen accounts, perhaps, for the lesser susceptibility to the depressing action of curare.

The peripheral motor paralysis in general affects nerve endings of all striated musculature. While systems other than the neuromuscular apparatus undoubtedly are affected to some extent, it is this action of the drug which is of primary interest.

When the drug is injected intravenously or intramuscularly into a human being the physiologic effects appear in from two and a half to ten minutes, the period depending on the method of administration. The patient complains of heaviness of the eyelids followed by bilateral ptosis, nystagmus, strabismus, diplopia, weakness of the muscles of the head and neck, inability to raise the head and loss of facial expression. Slowness and hesitancy of speech with weakness of the throat and jaw muscles rapidly follow. Then weakness and paralysis of the spinal muscles occur, followed finally by complete paralysis of the extremities. According to Bennett,¹⁶ the paralyzing effects of curare follow the same order as the progressive symptoms of a patient who has myasthenia gravis, and the double ptosis and nasal smile of the curarized patient simulate closely the appearance of the myasthenic patient.¹⁷

As is to be anticipated and desired, a drug so powerful as curare is not without its antidote, although Raleigh died before he was able to discover such a potion. It is natural to assume that the Indian users of curare knew

12. Sollmann, Torald: *A Manual of Pharmacology*, ed. 5, Philadelphia, W. B. Saunders Company, 1936, p. 1190.

13. Wintersteiner, O., and Dutcher, J. D., quoted by Thone, Frank: *Science News*. Curare Science n.s. (Suppl.) 95:10 (May 1) 1942.

14. McIntyre, A. R., and King, R. E.: d-Tubocurarine Chloride and Choline Esterase, *Science* n.s. 97:69 (Jan. 15) 1943.

15. Voluntary muscle is affected selectively, the muscles of high chronaxia being affected first.

16. Bennett, A. E.: Preventing Traumatic Complications in Convulsive Shock Therapy, *J. A. M. A.* 114:322 (Jan. 27) 1940.

17. Bennett has developed a diagnostic test for myasthenia gravis based on the patient's increased sensitivity to curare. He found that a fifteenth to a fifth of the average dose necessary to produce paresis in normal adult subjects produced a profound exaggeration of symptoms in myasthenic patients. The reaction was strongly positive even when the opposite prostigmine reaction was indefinite.

such antidotes and how to use them. This is true. Actually the Indians seem to have had better luck with antidotes than modern science has had until recently. The antidotes of the Indians were thoroughly mixed, being superstition and voodoo, bleeding by free incision of the wound inflicted by the curare-laden weapon, ligature above the site of the wound, liberal applications of rock salt into the incision and copious amounts of concentrated salt solution taken orally. Sollmann¹² stated that curare and physostigmine are mutually antagonistic. He also recommended stimulation of the sciatic nerve. To counteract the action of curare, present day users of the drug prefer prostigmine. Artificially induced convulsions are also apparently mutually antagonistic with curare, while artificial respiration and the administration of oxygen are life-saving measures when there is severe respiratory paralysis.

Therapeutic Use of Curare

Curare has been introduced into therapeutics and abandoned on many occasions since the middle of the last century. The irregular strengths and compositions of the drug frequently produced discouraging and untoward results, and its use consequently was restricted. Historically it has been tried therapeutically for a variety of illnesses and conditions, including rabies, tetanus, epilepsy, chorea and the muscular activity rigidities. Today curare is being investigated therapeutically in those fields and conditions in which muscular spasticity and increased muscular activity dominate the clinical picture. West¹⁸ has again investigated its usefulness in tetanus infections. Burman¹⁹ and Bennett¹⁶ have reported interesting results with its use in cases of spastic paralysis, cerebral palsies, Little's disease and dystonia musculorum deformans.

Since Griffith's²⁰ introduction of curare in the field of anesthesia, Lundy²¹ and his associates have used the drug with gratifying results as an adjunct to certain types of inhalation anesthesia for the production of more complete muscular relaxation when this is incomplete and intestinal distention constitutes an operative hazard. Reports on the use of curare in other processes in which muscular relaxation is desirable are awaited with interest. For example, curare has not been used as yet in orthopedic treatment, but it is my impression that the relaxation obtained from its use could be utilized to advantage in the reduction of fractures of the long bones. Fractures of the femur, for example, might possibly be reduced more readily than at present if the shortening due to muscular contraction could be overcome with curarization.

To date, however, curare has found its greatest field of usefulness as a "shock absorber" in making safe the use of convulsive shock therapy in the treatment of certain types of psychoses. Introduced as a means of preventing traumatic complications in convulsive shock treatments by Bennett¹⁶ in 1939, curare has been used already in an estimated 50,000 such treatments with only one fatality, a mortality rate of 0.002 per cent. This fatality occurred in a case in which proper precautions were not taken and in which artificial respiration was not used adequately.²²

The technic of the curarization employed preliminary to convulsive shock therapy as originally described by Bennett provided for the use of an in-

18. West, Ranyard: Intravenous Curarine in the Treatment of Tetanus, *Lancet* 1:12 (Jan. 4) 1936.

19. Burman, M. S.: Therapeutic Use of Curare and Erythroidine Hydrochloride for Spastic and Dystonic States, *Arch. Neurol. & Psychiat.* 41:307 (Feb.) 1939.

20. Griffith, H. R.: Use of Curare in General Anesthesia, *Anesthesiology*, 3:418 (July) 1942.

21. Lundy, J. S.: Personal communication to the author.

22. Bennett, A. E.: The Present Status of Convulsive Shock Therapy, *J. Nerve. & Ment. Dis.* 98:23 (July) 1943.

fusion or alcoholic extract prepared from crude curare. The lethal dose for mice was determined. A tenth of the lethal dose was used as the beginning dose for human beings. After sterilization, the drug was given intravenously, and within five minutes the shock was administered. The effects of the curare disappeared by the time the patient regained consciousness after the convulsion. A biologically standardized drug is now available for experimental use. The preparation is processed by E. R. Squibb & Company and is marketed under the trade name "intocostrin." With this preparation of the drug the dose is calculated at 1 mg. per 2 pounds (0.9 Kg.) of body weight, or 1 cc. per 40 pounds (18.1 Kg) of body weight. The maximal dose of the drug does not in any event exceed 5 cc.²³ The drug is given intravenously, a small gage needle and a 5 cc. syringe being used. From thirty to ninety seconds is taken up in completing the injection; within one and a half to two and a half minutes the convulsion is induced. If a convulsion of the grand mal type is sustained by the patient, the seizure apparently completely neutralizes the previous curarization.

Adequate precautionary measures in the use of curare require the immediate availability of solution of epinephrine 1:1,000 and solution of prostigmine 1:2,000 for intravenous administration in case of respiratory paralysis. It is also imperative that the physician be prepared to administer artificial respiration by either the Schafer or the Eve method.²⁴ It would seem that the Eve method has advantages over the Schafer method in treating respiratory paralysis after the use of curare. The preliminary use of curare widely increases the usefulness of convulsive shock therapy, and a series of 25,000 combined curare-electroshock treatments have been administered already without incident in the form of fracture or visceral injury.

STATION HOSPITAL PHYSICAL THERAPY

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The demands made by a large active post on the physical therapy section of a station hospital are chiefly for adequate treatment, the loss of as little time as possible from training or work and the avoidance of overtreatment. When the number of treatments exceeds a thousand a day, meeting these demands may prove difficult, especially when there are not enough accredited physical therapy aides.

Physical therapy at a station hospital differs from that at a general hospital in that the vast majority of patients have fairly simple complaints and consequently simple treatment requirements. Therefore, grouping the patients into classes facilitates their handling.

An analysis of the physical therapy at one of the large station hospitals revealed that 90 per cent could be classified as treatment of acute complaints or treatment of acute exacerbations of chronic complaints of the extremities and back. Treatment of the extremities as prescribed by the majority of medical officers usually required a sequence of whirlpool bath, massage and exercise. Treatment was therefore given to patients in groups of 6, since that number of whirlpool baths were available. Three massage tables were placed in the next room to accommodate the patients from the whirlpool

23. Petersen, Magnus: Personal communication to the author.

24. Medicine, Eve's Seesaw, Time Magazine 42:75 (Aug. 16) 1943.

baths; because the average massage took half as long as a whirlpool bath treatment. This room adjoined the gymnasium, where exercise instruction was given to groups. The competitive spirit produced by instruction given to small groups resulted in far better cooperation than was possible with individual instruction. In addition, individual attention was much more time consuming. When indicated, this was given by the physical therapy aide or the physical therapy section officer.

The same system was used for patients with complaints referred to the hand, wrist, forearm, elbow, arm, foot, ankle, knee or thigh. If a patient failed to appear at his appointed time, (which was arranged to facilitate group instruction), the only delay occurred at the end of the treatment, when he might have to rest a little longer while an adequate class was being accumulated.

For cases of back pain, luminous heat, massage and exercise usually were prescribed. Each enlisted attendant was assigned two tables. While one patient was being given luminous heat treatment, another was being massaged. At the conclusion of the massage, the patient was referred to the gymnasium for group exercise instruction.

The officers' whirlpool bath and a contrast bath were placed in a separate room. The contrast bath was so designed that a large central compartment functioned as a whirlpool bath, because this type of bath was more in demand. When it was used as a contrast bath, a compartment on each side made possible treatment of extremities simultaneously if this was desired. The massage plinth in this room kept the one enlisted attendant busy.

Ultraviolet ray treatment was given in a nearby room. Since this had to be administered accurately, but was of relatively short duration, the attendant filled in time with low frequency therapy applications and with muscle reeducation in the Hubbard tank room next door.

Treatments were given by enlisted men, supervised by a physical therapy technician and the physical therapy section officer. A course in physical therapy fundamentals and technic was instituted for these men. Daily lectures were given, and the material in these was emphasized and clarified by practical demonstrations throughout the day. Naturally, with relatively inexperienced enlisted attendants, treatment could not be as adequate as if sufficient skilled accredited physical therapy aides had been available. However, by constant practical application of knowledge acquired day by day, some of the enlisted attendants progressed to the stage where they were being taught muscle reeducation. To some, the very pronunciation of "latissimus dorsi" was impossible at the beginning, but with a knowledge of the origin, insertion and action of the muscle, this difficulty was overcome. As a matter of fact, the insistence of the men on medical terminology, e. g. "effleurage" rather than "stroking," was one of the surprising yet understandable reversals they demonstrated as their competence increased.

Two classes of patients were treated, out-patients referred by medical officers stationed at any dispensary throughout the camp; and in-patients referred by medical officers assigned to the hospital itself. Because every patient's life in a hospital revolves about treatment and the expectation of recovery, in-patients were treated twice daily whenever possible. Not only was recovery accelerated but the patient's morale was improved, since he felt that everything possible was being done to expedite his return to duty. Treatment was prescribed by the referring medical officer, and enlisted men, properly supervised, executed the orders. However, frequent consultation with the physical therapy section officer was the rule, especially concerning patients who were slow to respond. Individual treatment, when indicated,

was carried out by the physical therapy aide or the section officer. Participation in staff conferences further clarified the work of the department.

When it could be conceded that treatment was as adequate as trained enlisted personnel can give, a simple yet efficient record system was the next objective. Its basis was an executive order stating that no patient would be treated for more than a two week period without being reexamined by the referring medical officer.

A mimeographed form indicating the modalities which the physical therapy department had available made prescription easy. On this form were spaces to indicate the dates on which the patient was to come for treatment, and an area was reserved for notes of progress and objective evidence of improvement. When this form was returned, the referring medical officer quickly observed whether the patient had seriously cooperated in the treatment or had wasted elsewhere the time allotted to treatment. The referring officer decided whether further treatment was necessary. By this means, overtreatment was prevented and a more complete idea of the patient's progress was obtained.

When the patient entered the physical therapy department with his prescription form, this was filed away. In its place he was given a card on which was transferred the vital information contained on his referring slip, such as the diagnosis; the type, length, and periodicity of treatment, and the date of final treatment. If a whirlpool bath treatment was to be given, the secretary would write on the back of the card the letter X, Y or Z to indicate the enlisted attendant who would administer the massage, and a number to indicate the total number of whirlpool bath treatments which had so far been given. For example, Z 13 would denote that 39 patients had had whirlpool treatments so far that day. The enlisted attendant did not call out a name he couldn't pronounce, but, for instance, called for Y 10. Since the patient's card had this written on the back of it, he did not fail to respond. After passing through the whirlpool bath room the patient was treated in the massage room by the designated enlisted attendant, X, Y or Z. He was then referred to the gymnasium. The same system applied to patients with involvement of the back, except that A, B, C, D, E, F, G and H were used, with corresponding numbers. In the case of galvanic or faradic treatments, etc., other letters were assigned and the patients numbered as they came. At the end of the day, tallying was simple, being just a matter of addition.

When the treatment period was ended, the information on our card was transferred to the original referring form, and this was returned with the patient to the referring officer. Our card was put into an inactive file as a permanent record.

A graph form was used in every case of joint involvement for charting the improvement in degree of joint motion week by week, so that when the patient's treatment was discontinued, a permanent record of progress from admission to discharge was available. An 873L Lufkin Co., N. Y., rule was used for joint measurements rather than a roomful of elaborate individual joint-measuring apparatus. This rule consists of a combination spirit level, folding ruler and protractor, easily carried in the pocket and costing less than \$2, yet capable of easily measuring every joint motion worth determining.

A special mimeographed form showing the average peripheral sensory nerve distribution of the upper and lower extremity was used for indicating involvement of this innervation and its extent. The contrast to the normal, already indicated on the form, when absolute loss of sensation was colored

in red and dullness in blue, was all the more obvious to the clinician. This form was also very useful because it showed where sensitivity testing should be done.

A set of exercise forms was mimeographed for various types of postural backache, weak feet and weakness of the abdominal muscles so that the patient could carry on his treatment in barracks. By continuation of these exercises after the treatment period was over, recurrences were prevented.

Through the use of this plan, waiting was minimized and the soldier could be back on duty within two hours after leaving for his treatment. Though there might be more than a thousand treatments during a day, eighteen waiting chairs were more than adequate to accommodate the men waiting for treatment.

Because our purpose in the Army is to return the patient to duty, *fit for duty*, exercises in all its forms was emphasized. Standard exercising apparatus, for which the American Medical Association Council on Physical Medicine supplied plans or a book such as Krusen's "Physical Medicine"¹ described, were used. None of these was difficult to build, although competent workmanship was essential. All the apparatus to be described was constructed by our hospital utility shop and functioned well, even in the hands of a group of ambitious convalescents who visited the physical therapy gymnasium daily as part of their convalescent program.

The treatment tables, twenty-four in all, were constructed with an extra shelf below, the length of the table, to stiffen the table materially and to hold sheets, towels, etc. A set of standard exercise steps also became a part of our armamentarium.

The shoulder wheel was modified by installation of a brake mechanism. This was done by removing a segment of the long axis of a pipe one size larger than the axle of the wheel and bringing about pressure of the split, larger size pipe on the axle. Braking could be varied in its effect by means of a thumb screw arrangement.

The Kanavel table was improved by installation of the same adjustable braking device on the elbow wheel, wrist-exercising end. By use of short leaves of a junked automobile spring with wing nut tension over the ends, energy requirements of the wrist-elbow flexion and extension unit could be varied according to progress of the individual patient. A wrist exerciser was added by installation of two upright $\frac{1}{2}$ -inch pipes, 12 inches high, between which was hung a piece of metal, shaped like a cross, suspended from rubber bands. This was designed to fit the hand comfortably either in full pronation or supination or midway between these two extremes. In the midposition, wrist flexion and extension were carried out if the elbow was fixed. In the full pronation or supination position radial and ulnar deviations were emphasized. A protractor mounted behind the "cross" provided the patient with objective proof of his improvement as it took place. A similar protractor was mounted behind the pendulum pronation-supination device.

An adjustable set of parallel bars for reeducation in walking was constructed from $1\frac{1}{4}$ and 1-inch pipe. A walker for the same purpose was welded from $\frac{3}{4}$ -inch pipe.

Extra whirlpool baths actuated by water pressure were fabricated. These functioned as efficiently as did the unobtainable motor-driven variety, and the constant flow of water through them helped discourage skin infections. Standard hot water heating system thermometers were used as water temperature gages.

1. Krusen, F. H.: *Physical Medicine*, W. B. Saunders Co., Philadelphia, 1941.

A contrast bath was made with three compartments, a large central and two smaller side spaces. Because contrast baths were not as frequently used as whirlpool baths, the central compartment was fitted with a water pressure-actuated whirlpool device complete with temperature gage, which converted this compartment into a whirlpool bath.

A foot gymnasium was created by the assembly in close proximity of foot and leg exercising equipment. Rounded knobs screwed to the floor became our short sole muscular exercisers. The ordinary foot inverter boards were modified by having placed between them a 5-inch horizontal slat. This was used to improve the sense of balance when the patient walked with the feet straight ahead. A foot block for inversion and achilles stretching of the tendon was placed next to a foot inverter muscle exerciser. The latter consisted of webbing to be looped around the metatarsal region of the foot and attached to a rope passing through two small pulleys, so that if the heel was fixed a 4-pound weight would be raised when the foot was inverted. Osgood² has shown that if the foot inverters were stronger than the everters in a proportion of five to four, the feet were not so apt to cause pain as if the opposite relationship was present. An ankle exerciser consisted of two bed springs overlaid by a board, cut out in the size and shape of an average foot and hinged at the instep.

A wrestling machine was constructed from a Ford mechanical front wheel brake, to whose five lug bolts, 2 foot lengths of 1-inch pipe were welded. This was mounted vertically on a wall. Brake tension was controlled by a wing nut.

The same apparatus, with 3 foot lengths of 1-inch pipe welded as stated, mounted horizontally on a platform 36 inches high, became an exercise wheel for back, leg and arm development. Brake tension adjustment here was similar to that of the wrestling machine.

Owing to the lack of available hardwoods, the stall bar set was constructed of scrap 1-inch pipe. A Sayre sling was made from a length of 1/2-inch pipe, with pipe cap ends, in the shape of a clothes hanger. Four thicknesses of ordinary muslin 36 inches long and 3 inches wide sewed in two thicknesses to form three sections of 12 inches each was used for the chin and occiput support.

A hand exerciser was created from a small tank 18 by 5 inches, a 15-pound steam gage, a length of rubber tubing and a sphygmomanometer bulb and valve. The average soldier in good condition could pump 8 pounds of pressure into this tank. Men with finger or hand injuries were much intrigued with their gradual visible progress and never failed to continue hand exercises, even when away from the physical therapy gymnasium, on an extra sphygmomanometer bulb supplied by the ward nurse or, if they were outpatients, on balls of crushed newspapers about the same size.

By connecting a hand type tire pump to a 15 gallon boiler through a discarded tire valve, installing 15 pound steam gage and a pressure cutout set for 14 1/2 pounds, we evolved a triceps and elbow exerciser. Because some elbow fractures were followed by considerable restriction of motion, this device was a great help for mobilization. The interest of the elbow patient in trying daily to increase his tank pressure was heightened in effectiveness through his adherence to an elbow mobilization exercise schedule during the rest of the day, when he was not in the physical therapy gymnasium. We created a lower extremity exerciser with similar features by adding to the same apparatus a foot type tire pump.

2. Osgood, R. B.: Important Etiologic Factor in So-Called Foot Strain, *New England J. Med.* 226: 552 (April 2) 1942.

To the standard pulley and weight exerciser was added a pulley placed near floor level. A rope extending from a loop about the patient's shoe ran through this pulley to a detachable clip on one of the handles of the apparatus. This assembly made possible an excellent thigh muscle exerciser. In addition, a series of progressive weights (sandbags) which the seated patient raised from the floor by a loop over his dorsal metatarsal region was used, particularly for quadriceps strengthening.

A Hubbard tank was installed for trunk, hip and shoulder muscle training and treatment. This had a portable water pressure-actuated whirlpool attachment which could be used where needed with the help of a length of garden hose. Trunks were made for use in the tank, were made from muslin 36 inches long and 18 inches wide. An arc 12 inches long by 7 inches deep was removed from the center of the long sides, a 4-inch crotch being left. Draw strings were attached to the top and bottom and around the sides of the crotch cutout.

The gages of the Scotch douche consisted of combination hot-water heating system units indicating both pressure and temperature on the same dial. The temperature was first preset by adjustment of both hot and cold water supply valves placed proximal to the gage. Pressure was then corrected by a valve distal to the gage.

Since the physical therapy gymnasium contributed to the hospital convalescent program, a 75 pound dumbbell was constructed from two 6-inch segments of 4-inch iron pipe filled with lead and connected by a piece of 1-inch pipe 42 inches long. Smaller dumbbells were constructed similarly. A striking bag was installed for the improvement of muscle coordination.

The gymnasium itself was located at the rear of the building. This made it possible for the convalescent to come in by the rear door and not interfere too much with physical therapy in progress.

All the exercise equipment was designed to stimulate the patient's interest. Protractors were mounted wherever possible, and other objective means of establishing improvement trends were used, such as gages and adjustable braking devices.

The chief aim of the physical therapy physician in wartime should be restoration of the soldier patient to duty as soon as possible. Since there are an insufficient number of physical therapy aides and a dearth of factory-built equipment, it is hoped that this description of procedure and apparatus will be found of value.

ARTIFICIAL RESPIRATION—MANUAL AND MECHANICAL

In all cases of asphyxia it is of paramount importance that artificial respiration be administered immediately. Loss of a minute may mean the difference between life and death. There is little hope of reviving a victim who has ceased to breathe for more than five to seven minutes and even less chance if he has been in a state of apnea for more than ten minutes. Effective artificial respiration may be applied by the acceptable manual methods—Schafer prone pressure and Howard-Silvester methods—or by mechanical means—respirator or resuscitator. The inhalator is a valuable adjunct to manual methods of artificial respiration. One disadvantage to mechanical apparatus, either resuscitator or inhalator, is that it is not always on the scene of an accident and precious first minutes or seconds may be lost waiting for its arrival.

All rescue crews, and also the public, should be taught a correct method of administering manual artificial respiration. The one most generally used is the Schafer prone pressure method, which may be administered effectively by one person. The American Red Cross, the Boy Scouts and the Y. M. C. A. give instruction in this method. Physiologic experiments prove that an exchange of air in the lungs is achieved when the method is applied correctly. The Council highly recommends that every man, woman and child take advantage of the opportunity made available through defense activities to learn how to apply manual artificial respiration.

The Howard-Silvester method is somewhat more cumbersome to administer and requires the services of a team of trained persons. The Coast Guard uses this method.

In 1932 Dr. F. C. Eve of Hull, England, described a new method of artificial respiration which is unlike all previous methods mentioned. It is a rocking method, and the force of gravity causes the abdominal organs to shift, thus moving the diaphragm in and out like a bellows. It has been adopted on the British warships. In Eve's method the drowning victim is laid face downward on a stretcher and is well wrapped with blankets. His wrists and ankles are lashed to the handles. Then he is hoisted on a trestle or sling and rocking is begun. This method, according to Dr. Eve, is best because in cases of drowning the inspiratory recoil may be lost as the result of loss of tone in the diaphragm, and it is independent of tone. This method is safe and can be done by any one, but the disadvantage is that the equipment, although simple, may not be on hand in emergency cases when it is needed.

Included in the Council's list of accepted devices are inhalators and resuscitators, the two types of apparatus for administering mechanical artificial respiration. These devices are often confused as to function; the following briefly describes them:

Inhalators provide an atmosphere of oxygen and carbon dioxide gas mixture slightly higher than atmospheric pressure around the mouth and nose of the victim and are used in conjunction with an approved method of manual artificial respiration. Inhalators consist essentially of a face piece, rubberized fabric breathing bag, pressure reducing valve, tanks of carbon dioxide-oxygen mixture and carrying case.

Resuscitators create positive and negative pressure by means of a mechanical appliance operated by the energy of the stored gas merely positive pressure only. A face piece, reduction valve, tanks of carbon dioxide-oxygen mixture or merely tanks of oxygen, a carrying case and a reciprocating mechanism are the principal parts of the resuscitator.

The efficacy of the two types of appliances has been shown to be essentially the same by the evidence coming to the Council. Records show that when an inhalator and a resuscitator are on the scene of an accident at the same moment, and if either one is employed efficiently, the final result will not differ.

The Council on Physical Medicine is now carrying on a five year survey and is supporting research on artificial respiration. It is hoped that this work will produce additional data. — Reprinted with permission, J. A. M. A. 126:865 (Nov. 25) 1944.



ARCHIVES of PHYSICAL MEDICINE

OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL MEDICINE

.. EDITORIALS ..

QUANTITATIVE EVALUATION OF MUSCLE FUNCTION

In order to estimate accurately the extent of damage to the neuromuscular mechanism and to observe progress in paralyzes, it is necessary to have some system for the quantitative estimation of muscle function. Up to the present time, no entirely satisfactory program has been developed. Functional testing of muscle groups against gravity and manual resistance is of definite value and in busy departments of physical medicine may be all that can be attempted. The personal factor in this method is strong, however, and unless the progress of the individual case can always be determined by the same technician, some of the significance of the procedure is lost.

In the present issue of the ARCHIVES, Watkins and Brazier¹ present an excellent discussion of various methods useful in the evaluation of muscle function in poliomyelitis and in peripheral nerve injuries. After mentioning defects of the manual method of functional testing, these authors direct attention to value of the ergograph in examining muscles which are able to do some work. After pointing out the diagnostic limitations of faradic and galvanic stimulation and chronaxie testing, the authors show the advantage of voltage-capacity or strength-duration curves in watching the progress of neuromuscular recovery. In 1940 Dail et al.² presented an experimental study on dogs indicating the value of strength-duration curves in following the progress of paralysis subsequent to peripheral injury. Watkins and Brazier also demonstrate the importance of the electromyograph in the estimation of neuromuscular damage and in observing the progress of recovery. The authors have found this instrument useful in the study of the incoordination resulting from disturbance of the reciprocal innervation of opposing muscles as well as in the determination of action potentials of individual muscles.

This paper and other papers by the same authors, referred to in this article, are worthy of careful study by those interested in neuromuscular problems. Although some of the methods described might be too time consuming for the handling of a large number of patients, they are, nevertheless, of great interest and teaching value and could doubtless be employed in selected cases.

COMBINED THERAPY

An important therapeutic development of recent years is the combination of drug therapy and physical therapy. This is a natural outgrowth of remarkable progress in pharmacology and physical therapy, both of which are relatively young sciences. Already several combinations have been worked out and are being used effectively in combating disease. These are fever-chemotherapy of syphilis, fever-sulfonamide therapy of gonorrhea and other acute infections, ion transfer of histamine, acetyl-betamethylcholine and other chemical sub-

1. Watkins, A. L., and Brazier, M. A. B.: Studies on Muscle Innervation in Poliomyelitis and Nerve Injuries, *Arch. Phys. Med.* 26:69 (Feb.) 1945.

2. Moor, F. B.; Dail, C. W., and Kellogg, K.: Practical Implications of Strength-Duration Curves in Early Paralysis, *Arch. Phys. Ther.* 21:396 (July) 1940.

stances, the use of local chilling to retard the rate of absorption of penicillin and the use of curare in electric shock treatment.

The combination of chemotherapy and artificial fever in the treatment of syphilis is an example of true synergism, a term used heretofore to indicate a potentiation of the action of two simultaneously acting drugs as opposed to a simple summation of their effects. Kendall et al.¹ in the intensive fever chemotherapy of early syphilis were able to reduce the total dosage of mapharsen to approximately one tenth of that used in short term intensive chemotherapy. The results of intensive fever-chemotherapy compared more than favorably with those of intensive chemotherapy. The same evidence of synergism is seen in the fever-chemotherapy of neurosyphilis.

Although, since the introduction of penicillin, very few cases of gonorrhea or its complications are given fever-sulfonamide therapy, synergism here also has been well demonstrated. White² in 1939 found that the bactericidal activity of sulfanilimide and sulfapyridine could be increased a hundred fold in vitro by increasing the temperature from 99.2 F. to 102.2 F. Since the original report of Ballenger et al.³ on the effectiveness of combined fever and sulfonamide therapy in gonorrhea, many other investigators have observed the same synergistic action in this disease. Similar though less marked potentiation has been observed in certain other acute infections.

Although the use of positive galvanism in the ion transfer of histamine and acetyl-beta-methylcholine cannot be classified as an example of synergism, nevertheless this combination has produced a useful method of treatment. A variety of other organic and inorganic chemical agents can be introduced into the skin by galvanism for therapeutic purposes: alkaloids and metals from the positive terminal, halogens and other negative ions from the negative.

A recent study by Trumper and Hutter⁴ shows that the absorption of penicillin after injection can be greatly retarded and the bacteriostatic blood level maintained as long as six to twelve hours by the application of the ice bag over the point of injection. By the employment of this technic one 50,000 unit injection of penicillin in each of 18 cases of gonorrhea produced cures in seventeen.

In this issue of the ARCHIVES will be found an article by Kuitert⁵ on the pharmacology of curare and its use in connection with convulsive shock therapy. By blocking motor impulses in the receptive substance of the muscle, curare prevents the injuries sometimes resulting from excessive muscular contraction during the convulsion. The author states that in a series of 25,000 curare-electroshock treatments no instance of fracture or visceral injury has been observed.

The future will doubtless witness other combinations of drug therapy and physical therapy. It is an intriguing field of investigation which may make important further contributions to therapeutics.

1. Bundesen, H. N.; Bauer, T. J., and Kendall, H. W.: The Intensive Treatment of Gonorrhea and Syphilis, *J. A. M. A.* 123:816 (Nov. 27) 1943.

2. White, H. J.: The Relationship Between Temperature and the Streptococcal Activity of Sulfanilimide in Vitro, *J. Bact.* 38:549 (Nov.) 1939.

3. Ballenger, E. G.; Elder, O. F.; McDonald, H. P., and Coleman, R. C.: Failures in the Treatment of Urinary Tract Infections with Sulfanilimide, *J. A. M. A.* 112:1569 (Apr. 22) 1939.

4. Trumper, Max, and Hutter, A. M.: *Science* 100:432 (Nov. 10) 1944.

5. Kuitert, J. H.: Curare: Its Pharmacology and Its Use as an Adjunct to Convulsive Shock Therapy, *Arch. Phys. Med.* 26:99 (Feb.) 1945.



MEDICAL NEWS

Colonel Brooke Made Member of Baruch Committee

At the meeting of the Baruch Committee on Physical Medicine on October 9, held in Washington, D. C. Lieutenant Colonel Brooke represented the medical director of the Veterans Administration and was elected a member of the committee.

Physical Therapist Recruitment

The Office of the Surgeon General has authorized publication of the following information pertaining to physical therapists:

At the present time the authorization for physical therapists in the Army is 1250 and this ceiling has almost been reached. By July 1 we will have 350 more physical therapists, who are now in training, ready for duty. All of these might not qualify. Under these circumstances we are attempting to get our authorization increased because of the need for this additional personnel.

We are commissioning qualified physical therapists direct from civilian life at the present time but because of the ceiling which has almost been reached and the number of physical therapists now in training we have not been conducting an active publicity drive for them.

Recruitment of civilians for enlistment in the WAC for physical training courses has been stopped.

Approved Courses for Physical Therapy Technicians

The Council on Medical Education and Hospitals of the American Medical Association at its recent meeting held in February voted to extend its approval to the following schools for physical therapy technicians:

REGULAR COURSE:

University of Kansas School of Medicine, Kansas City, Kansas.

EMERGENCY COURSE:

Bushnell General Hospital, Brigham, Utah (approval granted subject to inspection of the school).

At the same meeting the school for physical therapy technicians conducted by the Station Hospital at Fort Huachuca, Arizona, was removed from the list. This action was the result of information from the Surgeon General's Office to the effect that the school was being transferred to Bushnell General Hospital, Brigham, Utah.

Physical Medicine in Veterans Administration

Lieutenant Colonel Charles R. Brooke, Medical Corps, A. U. S., has been transferred from the Bronx facility to the central office, Medical and Hospital Service, where he will serve as Chief of Physical Medicine and Rehabilitation.

A treatment plan is being developed to extend the scope of physical therapy, occupational therapy, physical exercise and recreation and to coordinate these activities for the purpose of physically and mentally rehabilitating veterans in order that they may pursue vocational training if feasible, or enable them to return to a gainful occupation.

A program for paraplegics is announced for the veterans administration. Their load of spinal injury cases is increasing due to transfers from Army hospitals. At this time, there are approximately 200 veterans suffering from spinal cord injuries with paraplegia. Heretofore, cases of this type have been considered hopelessly bedridden and helpless. A program of treatment has been formulated and will be carried out, under the general supervision of Colonel Brooke, in specially designated Veterans Administration facilities. The patients are grouped in a separate room or dormitory as far as their physical conditions will permit to facilitate medical treatment, nursing care, and routine physical therapy which is carried out daily. The grouping of these patients sustains their interest and stimulates their efforts to obtain maximum improvement.

This treatment is started early, at the bedside if necessary and as the patient progresses it is continued in the department of physical therapy. These patients are taught from the beginning to turn themselves in bed and to be self-sufficient as far as possible. Every effort is made to prevent the development of decubitus ulcers or, if already present, they are treated in order that the program prescribed for exercise may be fully carried out for the unaffected groups of muscles and as far as possible for affected extremities. Braces are applied as early as feasible and intensive instruction given in walking with the assistance of parallel bars, mechanical walkers and finally crutches for with full cooperation of the medical staffs, many paraplegics will be able to go about on crutches.

Veterans Administration

The "Annual Report of the Administrator of Veterans' Affairs for the Year 1944," states that advances of the Allied forces on all battle fronts gave impetus to plans for the civil reestablish-

ment of returning veterans. Following previous wars, benefits were offered principally to persons disabled in service and to their dependents. Recognition has now been given to the fact that the future welfare of all citizens is inseparable from that of the returning veteran, who must be well equipped to do his part in forging the destiny of the Nation. Accordingly, there was enacted the Servicemen's Readjustment Act of 1944, popularly called the "G. I. Bill of Rights" (Public No. 346, 78th Cong.). This law not only provided the structure for rehabilitation of veterans, but it recognized "the Veterans' Administration not only as an important post-war agency but an exceedingly important war agency." It was declared an essential war agency, second only to the War and Navy Departments in priorities. This gave legislative sanction to the close liaison that had been maintained with these departments, and removed impediments in the proper administration of veterans' affairs.

The total number of veterans remaining in hospitals rose from 56,641 at the beginning of this year to 63,800 at its close, an increase of 7,159. During the same period the World War II load advanced from 5,132 to 13,707, an increase of 8,575.

All neuropsychiatric hospitals are giving electric shock therapy or preparing to institute this form of treatment which has largely supplanted insulin subshock therapy, although the latter is still the preferred method in certain cases. Fever therapy has also been instituted in a number of hospitals. Experience with electric shock therapy has been most encouraging, particularly in those cases of manic depressive psychosis, involutional melancholia, reactive depression and the catatonic type of dementia praecox. Its field of usefulness is enhanced by the fact that the majority of the acute psychoses now being admitted are found among the rapidly increasing number of World War II veterans.

In the administration of the vocational rehabilitation and educational functions of the Veterans' Administration, in order that vocational counseling and induction into training might be accomplished more conveniently at points nearer the homes of disabled veterans than the regional offices as well as with the purpose of effecting closer cooperation between our educational institutions and the Veterans' Administration, arrangements have been made for the setting up of guidance centers at a number of colleges and universities throughout the country. Beginning with the College of the City of New York, which was the first to offer the necessary facilities for the purpose, contracts are being entered into between the institutions and the Veterans' Administration whereby it is provided that the services of the personnel of college staffs who are skilled in administering tests of ability and aptitude and in various phases of educational, vocational and personal counseling may be most effectively utilized.

Symposium on Low Back Pain

Recently the New England Society of Physical Medicine conducted a symposium on low back pain at the Hotel Kenmore, Boston. The speakers were Drs. John G. Kuhns on "Orthopedic Management" and William Jason Mixter, "Ruptured Intervertebral Disks," both of Boston.

Kellogg Grant for Rehabilitation

A substantial grant from the W. K. Kellogg Foundation of Battle Creek, Michigan, enables the National Council on Rehabilitation to extend its scale of operations during 1945. Up to this time, the work of the Council has been conducted as a volunteer activity by the members of the Executive Committee, assisted by the Office Secretary, Miss Ursula Stoothoff.

Effective February 1st, the Council has engaged Mr. David Salmon as Executive Director.

Bell Greve Consultant on Rehabilitation

Miss Bell Greve the Secretary-General of the International Society for the Welfare of Cripples and Chairman of the Ohio Council for the Handicapped is now Consultant on Rehabilitation, Welfare Division of the United Nations Relief and Rehabilitation Administration, Washington, D. C.

Occupational Therapy

The American Occupational Therapy Association, 175 Fifth Avenue, New York City, has made available to occupational therapists and hospital workers a Package Loan Library which at the present time consists of Occupational Therapy as a Profession, Occupational Therapy in Mental Hospitals, Occupational Therapy in Tuberculosis, Occupational Therapy with Rheumatic Fever Cases, and Curative Workshops.

Rehabilitation

The Physical Demands of Daily Life, by George G. Deaver, M.D., and Miss Mary Eleanor Brown, is the first of a series of rehabilitation publications being issued by the Institute for the Crippled and Disabled.

General Bliss Dedicates McGuire General Hospital

Brigadier General Raymond W. Bliss, U. S. A., Assistant Surgeon General, dedicated McGuire General Hospital in Richmond, Va., on January 23 as part of the "chain of hospitalization which supports our fighting men overseas." Plans for making the hospital a specialized center for amputations and neurosurgery have been set for the near future, he said.

McGuire General Hospital is named in honor of Dr. Hunter McGuire, a Virginian, who was

chief surgeon under the command of General T. J. ("Stonewall") Jackson during the Civil War. Surgeon McGuire held a position in the Confederate Army parallel to that of Surgeon Lettman of the Federal Army.

Conference on Convalescent Hospitals

Service Command directors of reconditioning conferred recently with the commanding officers of convalescent hospitals at Lexington, Va., and discussed problems of organizing and operating convalescent hospitals under the broadening reconditioning program. The conference was addressed by Colonel Augustus Thorndike, MC, Director of the Reconditioning Consultants Division, Office of the The Surgeon General, who stressed the continuation of the original mission of reconditioning: to refit men either for return to duty or to civilian life.

Back to Normal

This is the title of a film revealing the part played by modern science in the making and fitting of artificial limbs, by means of which disabled persons are able to follow their old occupations or work at new trades which are taught them at Government Training Centers. It was made at Roehampton, one of Britain's hospitals devoted to the treatment of limbless war casualties—men, women, and children. Participating in the film are former patients of Roehampton Hospital as they are today, working, and enjoying their recreation and sports like other people.

Back to Normal shows how men with artificial limbs are able to work at engineering, drafting, carpentry, metal-beating, and painting and decorating—all of them highly skilled occupations which formerly they could not have followed. With the aid of special tools provided by the Government, they are now able to work at these trades with speed and absolute efficiency.

You see these "disabled" men, women and children in their hours of recreation—playing tennis, golf, billiards, dancing, or driving cars.

The film explains how these people are taught to use their new limbs, and how the joint on a modern artificial leg can be locked and set at various tensions, permitting its wearer to sit down and stand quite naturally.

It is an interesting film—detailed and explicit in the treatment of the subject. Also it stresses the point that, although the State accepts the responsibility for these men and women, the final responsibility rests with the community—to accept them and to judge them, not by their disabilities, but by their abilities.

The film consists of 2 reels, requires sixteen minutes to run. The loan price is 75 cents, the purchase price is \$17.50.

Misbranded Products

Abstracts of Notices of Judgment issued by the Food and Drug Administration of Federal Security Agency.

[Editorial Note.—These Notices of Judgment are issued under the Food, Drug and Cosmetic Act, and in cases in which they refer to drugs and devices they are designated D. D. N. J. and foods, F. N. J. The abstracts that follow are given in the briefest possible form: (1) the name of the product; (2) the name of the manufacturer, shipper or consigner; (3) the date of shipment; (4) the composition; (5) the type of nostrum; (6) the reason for the charge of misbranding, and (7) the date of issuance of the Notice of Judgment—which is considerably later than the date of the seizure of the product and somewhat later than the conclusion of the case by the Food and Drug Administration.]

Pine Glow Bath and Rainbo Bath. — Rainbath Laboratories, San Francisco. Shipped Feb. 16, 1942. Composition: Pine Glow Bath, essentially water, with the sodium salt of a sulfonated oil, and volatile oils, including oil of pine needles; Rainbo Bath was essentially a lime-sulfur solution. First product misbranded because falsely represented in labeling as effective in overcoming insomnia, aiding health and benefiting muscular rheumatism and gout and eliminating poisons, increasing the white corpuscles and bringing about weight reduction. Rainbo Bath misbranded because of false label representations that the product was colloidal sulfur and that when placed in the bath water would give the benefits derived from the treatments at hot springs and spas. — [D. D. N. J., F. D. C. 836; December, 1943.] Reprinted with permission J. A. M. A. 127:164 (Jan. 20) 1945.

Poliomyelitis in Russia

Since the start of the war there have been few cases of polio in the Soviet Union, Dr. Sofia Markina, director of the Dzerzhinsky Children's Hospital in Moscow, told Leo Gruliov, Russian War Relief representative, and Lillian Hellman, American author and playwright, who made a tour of this 400-bed hospital, outfitted with American blankets, sheets, pajamas and medical supplies sent by the relief agency.

The virtual disappearance of poliomyelitis among Russian children was attributed by Dr. Markina to the wide dispersal of these children during the evacuation which took place early in the war.

The relief representative, who cabled this information to the agency's headquarters in New York City also reported a decline of rheumatic fever among children, a decrease which Dr. Markina feels is due to the lack of protein content in Russia's wartime diet. This dietary insufficiency, Dr. Markina pointed out, has, however, created other serious nutritional cases requiring sanatorium treatment. Citing an absence of epidemics as a whole, she indicated as a special wartime problem the rise in malaria carried by children who returned from evacuation points in Central Asia.

BOOK REVIEWS

THE 1944 YEAR BOOK OF PHYSICAL MEDICINE. By *Richard Kovács, M.D.*, Professor of Physical Therapy, New York Polyclinic Medical School and Hospital; Attending Physical Therapist, Manhattan State, Columbus and West Side Hospitals; Visiting Physical Therapist, Department of Correction Hospitals of New York City and Harlem Valley State Hospitals, Wingdale; Consulting Physical Therapist, New York Infirmary for Women and Children, Mary Immaculate Hospital, Jamaica, N. Y.; St. Charles Hospital, Port Jefferson, L. I., and Hackensack Hospital, Hackensack, N. J. Cloth. Pp. 416, illustrated. Price, \$3.00. Chicago: The Year Book Publishers, Inc., 1944.

This is the 1944 Year Book of Physical Medicine. The American Medical Association has changed its council's name to Council on Physical Medicine and the name of the American Congress of Physical Medicine was changed at its 1944 session. In accordance with these changes the title of the Year Book is also changed to its present title. The author has abstracted the world's literature in physical medicine and there are scores of positive new advances and new refinements in both diagnosis and treatment presented within these covers. Part one gives the recent advances in all phases of physical therapeutic methods, and part two shows how physical medicine is applied in such conditions as war injuries, cardiovascular conditions, peripheral vascular diseases, respiratory conditions, arthritis, traumatic conditions, backache, foot conditions, infantile paralysis, spastic paralysis and peripheral nerve injuries. Abstracts are also quoted of the applications of physical agents in medical, gynecologic, proctologic, dermatologic, ophthalmologic, and rhinolaryngologic conditions. It is a "must" book for all physicians using physical medicine.

PHYSICAL DEMANDS OF DAILY LIFE. AN OBJECTIVE SCALE FOR RATING THE ORTHOPEDICALLY EXCEPTIONAL. By *George G. Deaver, M.D.*, and *Mary Eleanor Brown, M.A.*, Physical Therapist. Paper. Pp. 36, illustrated. Price, 10 cents. New York: Institute for the Crippled and Disabled, 1945.

The authors believe that until the elementary physical demands of locomotion, self care and the use of the hands are satisfied, future vocational placement in any self-supporting position is unlikely. They give in this booklet a rating scale which they have devised to judge the ability of the subject to perform the activities involved in locomotion and traveling, self care and the use of the hands. The activities in the rating scale have been chosen as representative ordinary everyday activities associated with daily life which require no special skill and

which it is taken for granted the average person can perform. For convenience, the physical activities of daily life are considered separately from the physical demands of daily work. The summary of the rating scale results is to be made and used by the person in charge of the training program of the subject as a basis for instruction.

AND NOW TO LIVE AGAIN. By *Betsy Barton.* Cloth. Pp. 150. Price, \$1.75. New York: D. Appleton-Century Company, Inc., 1944.

This book is of interest to all those working in rehabilitation because it is written by a girl whose back was broken at the age of thirteen in an automobile accident and who remained paralyzed for ten years. She discusses the problems of the disabled with clarity and candor because she was an old experienced patient. She says in her introduction: "Ten years ago my spine was badly smashed in an automobile accident. Both legs were paralyzed. Since that time I have found my way through the maze of rehabilitation. I have done all the wrong things and made all the mistakes it is possible to make and still survive." This book shows how the wounded can be helped through understanding and love on the part of their families and friends. It gives a positive philosophy and faith which helps the disabled to face life again with hope and determination. Betsy Barton describes how we do not appreciate what we have until we lose it. The author emphasizes early physical medicine. "I have seen the fatal results of rescue work begun late." She has also seen that the effort to recover must enlist mind and heart as well as the body. It is shown how too often the patient is looked on as a physiologic mechanism and is studied by means of medical history and physical examination that carry the erroneous notion of exactness and thoroughness, erroneous because the emotional life of the person which may hold the key to the solution of the problem is not investigated or at best inadequately so. The author considers that the farther we progress up the age scale the more difficult readjustment may become because responsibility is greater when we are older, the tissues have lost their capacity for a come-back, and it is harder for an older person to adapt himself to a new type of job. The importance of breathing and body mechanics are given. "There were ninety-nine things I could not do then and two I could. And the only things I could do were these: to breathe and to exercise my tummy muscles. But upon these two exercises hung my health. With these two things as rungs, I started to climb the ladder of strength to win back my life." At times the author's sense of the dramatic overbalances the medical truth

of the story: "the man developed an arthritic knee . . . The man revealed a terrible fear of leaving the hospital . . . he knew he could no longer hold his old job . . . As soon as the man was reassured about this, the mass of hard bone formation around his knee began to dissolve and within a week it was entirely gone." It would seem a miracle cure of an arthritic knee. The author in her general discussion shows the magnitude of rehabilitation as shown by the report of the Baruch Committee, the need for trained physicians and technicians in this field and that physical medicine should be presented as a required course in every medical school. This book should be read by every physical therapy and occupational therapy technician treating the disabled and they should advise the disabled patients and their families to read it.

MASSAGE AND REMEDIAL EXERCISES IN MEDICAL AND SURGICAL CONDITIONS. By *Noel M. Tidy*. Cloth. Pp. 480 with 190 illustrations. Price, \$6.00. Baltimore: The Williams & Wilkins Company, 1944.

This is the sixth edition of a book which has long been a favorite. The principal alterations in this edition are in the sections dealing with fractures. The first three chapters have been almost entirely rewritten and several new illustrations have been added. The text deals with the employment of massage and remedial exercises in fractures, dislocations, sprains, stiffened and disease joints as well as in diseases of the nervous system and muscles. There are also chapters on the treatment of deformities of the spinal column, on the treatment of constitutional diseases, diseases of the heart, vascular system, respiratory organs and the abdomen and pelvis.

The book has been written by a technician for technicians and contains a wealth of information, much of it exceedingly valuable. It is to be expected that this book will continue to be well received.

LIPPINCOTT'S QUICK REFERENCE BOOK FOR MEDICINE AND SURGERY. By *George E. Rehberger, A.B., M.D.* Cloth. Price, \$15.00. Pp. 1,460 with 305 illustrations. Philadelphia: J. B. Lippincott Company, 1944.

This is the twelfth edition of a monumental and laborious work, the previous edition having been printed four years ago. The book consists of eleven parts dealing, respectively, with (1) general medicine and surgery, including neurology and the diseases of infancy and childhood, (2) gynecology, (3) genito-urinary diseases, (4) obstetrics, (5) skin diseases, (6) diseases of the eye, (7) diseases of the ear, (8) diseases of the nose, (9) diseases of the throat, (10) orthopedics, including fractures and dislocations, and (11) drugs — the whole field of practical medicine except psychiatry.

In this twelfth edition, the sections on gynecology and genito-urinary diseases have been entirely rewritten and the other sections have also

been revised. The list of drugs has been revised in accordance with the twelfth revision of the United States Pharmacopoeia and the seventh edition of the National Formulary. Additional discussion has been inserted in the fields of chemotherapy, shock treatment, burns, deficiency diseases and nutrition. New color plates have also been added in this edition.

This quick reference work fills a gap which exists in most physicians' libraries and should prove valuable to general practitioners and specialists alike. It provides a means of rapid reference to the salient points regarding a multitude of diseases.

NORMAL LIVES FOR THE DISABLED. By *Edna Yost* in collaboration with *Dr. Lillian M. Gilbreth*. Cloth. Price, \$2.50. Pp. 298. New York: The Macmillan Company, 1944.

According to the authors, this book is intended for men and women who have become disabled and want to know what the future holds. It is written for everyone who has a physical disability of any kind. It is presented with the belief that, with relatively few exceptions, handicapped persons can attain economic independence and a normal social existence and it tells them how to go about it. It will be of particular interest to the disabled but it is also written for families and friends, for everyone who wants to be an intelligent factor in helping the disabled person to achieve a useful and happy life.

The book urges every handicapped man and woman, veteran or civilian, to make the effort as early as possible to help himself. It is divided into four parts: Part I, Making up your mind to work; Part II, Getting ready for work; Part III, On the job; and Part IV, What about the future?

This text is a very timely presentation owing to the fact that rehabilitation of the disabled is an extremely pressing problem at the moment. The vast number of persons who have been disabled in the defense of our country, in the Army, Navy or defense industries; will welcome this important guide. Every physician specializing in physical medicine and every physical therapy and occupational therapy technician will want to read this book because of its extreme value in explaining the problems of the handicapped. The reviewer passed it around among a group of outstanding leaders in the field of rehabilitation and all of those who had read it, praised it profusely. It can be highly recommended.

PRACTICAL OCCUPATIONAL THERAPY FOR THE MENTALLY AND NERVOUSLY ILL. By *Louis J. Haas, F. A. A., O. T. R.*, Director Men's Therapeutic Occupations. The New York Hospital, Westchester Division, White Plains, N. Y. Cloth. Price, \$6.00. Pp. 432 with 356 illustrations. Milwaukee: Bruce Publishing Company, 1944.

The author of this book is highly qualified to write on this subject as he has had extensive train-

ing at the Maryland Institute of Art and Design and the Rhode Island School of Design and he has had many years of actual practical experience in applying the principles of occupational therapy at the Bloomingdale Hospital, the name of which was changed in 1936 to the New York Hospital, Westchester Division. The book is divided into three parts. Part one discusses the history, the mission and aims of the therapy, receiving the new patient and administering the prescription. One of the special features that the author gives in this latter chapter is the individualizing of the treatment and the relative importance of crafts applied to occupational therapy. There are case history reports to demonstrate the principles brought out. Part two discusses the departmental organization, records, the relation of this department to hospital service and the equipment.

Part three occupies over half of the book and contains much self-instructional material and practical craft information. In this section the author states: "It seems only natural that the occupational therapist, engaged in the conservation of human life, should be interested in working with salvaged materials." The crafts given are within reach of all, even when space and funds are limited.

At the end of each chapter there is an excellent bibliography. The illustrations are many and good. Although the experiences recorded in this book were

gained only in the field of the mentally and nervously ill, they are just as valuable in all other fields of occupational therapy. This book is specially valuable as Mr. Haas shows clearly that elaborate workshops and complicated equipment are not necessary for the benefits of occupational therapy to those who need it but that in many instances simple tools and easily obtained equipment, including waste material, may help bring about the desired result of restoration to a normal mental or physical condition. This volume is particularly timely because of its presentation of many methods of treatment that might be used for hospital members of the Armed Forces whose convalescence may not only be shortened but freed from the boredom of inactivity by the practical utilization of one or more of the manifold occupational activities described. This book can be recommended to the physician as a reference book. It should be in the library of every occupational therapist and student of occupational therapy.

REHABILITATION IN GREAT BRITAIN.

By British Information Services. Paper. Pp. 12. New York: British Information Services, 1944.

This brief pamphlet gives the development of Rehabilitation Services in Great Britain and the forms of therapy used as exercises and occupational therapy.

Circumstances that are beyond the control of the Central office have caused a delay in the mailing of the issues of the ARCHIVES. It is believed that this situation has improved and that future issues may be mailed more promptly. Your cooperation in notifying the central office of change of address, giving the zone number, will be appreciated. Please report as early as possible if you fail to receive your copy.

PHYSICAL MEDICINE ABSTRACTS

Modern Treatment of Anterior Poliomyelitis. **Ora L. Huddleston.**

Rocky Mountain M. J. 41:893 (Dec.) 1944.

During the past two years a new treatment consisting of combined artificial fever therapy and vitamin therapy has been developed. Intrathecal administration of thiamine chloride plus the oral administration of vitamin B complex and vitamin E combined with artificial fever therapy was used in the treatment of five cases of infantile paralysis. An earlier procedure employed intravenous and intramuscular administration of the vitamin B instead of intraspinal. Six cases were treated successfully using this procedure. The dosage of the thiamine chloride injected intraspinaly was 20 to 50 milligrams, eighteen to twenty-four hours prior to each successive fever treatment. The fever treatments were of short duration and low intensity. As a rule, a series of four to ten treatments were given with temperatures ranging from 103 to 105 F. with durations of only one-half hour at a temperature over 104 F. Vitamin C was given in doses of 150 to 200 milligrams during the fever treatment. The rationale for the use of artificial fever therapy in the treatment of anterior poliomyelitis is based on the belief that elevation of body temperature causes beneficial chemical changes in the spinal cord and a more rapid restoration of the reversible functional changes of the central nervous system. It is presumed that restoration of function of the nerve cells would be hastened in the cells that were not completely destroyed by the virus.

Poliomyelitis. Charles Varga.

Arch. Pediat. 61:636 (Dec.) 1944.

The year of 1944 will be recorded as one during which poliomyelitis occurred in an epidemic form surpassed only a few times before in medical history. This is obviously of great concern to physicians and public health workers for their studies have not yet brought this disease under control.

The newer concepts of poliomyelitis have been reviewed and an attempt has been made to present actual cases which indicate the various manifestations of poliomyelitis as seen in the 1944 epidemic in New York City.

Certain sensory manifestations in persons suffering from the disease are explained on an anatomical basis inasmuch as sensory ganglia show involvement. Involvement of the entire nervous system seen at autopsy indicates that the disease is generally a polioencephalomyelitis. Pathologic changes appear in the internuncial neurons and degeneration of the synaptic associations on the surface of the anterior horn cells in many cases; thus muscular spasm may have a neurogenic

basis. Recovery of muscles which occurs in many cases is explained on the basis of partial degenerative changes from which neurons recover rather than on the basis of disappearance of edema. Atrophy, fibrillation and changes in chemical and electrical excitability are the fundamental features of degeneration and denervation of skeletal muscle.

Secondary changes in muscles following immobility and disuse seem to be more severe than those following overactivity. Periodic electrical stimulation of denervated muscle can decrease atrophy. When the strength of voluntary contractions of muscles increase through treatment, spasticity decreases. The upper portion of the alimentary tract seems to be the portal of entry of the obligate neural virus. The incubation period averages twelve days; the infectious period lasts from four days before to five days after the onset of symptoms. The agent escapes by way of stools and secretions of the upper respiratory tract. Flies may be vectors; the common house fly is not generally a vector.

The mode of spread is possibly by contact or contamination of foods. The incidence of bulbar and bulbospinal poliomyelitis is significantly higher in those patients who had had tonsils and adenoids removed in early life. The problems of immunity are not well understood. Pregnancy complicated by poliomyelitis does not generally result in an infected fetus. Certain precautions must be taken in cases associated with respiratory complications. The use of prostigmine has been advocated on an anatomico-physiologic basis. The efficacy of serum therapy is debatable. An outline of therapy is presented.

Experimental studies with monkeys have shown that nontraumatic exposures to the virus of the respiratory and alimentary mucous membranes of cynomolgus monkeys may be followed by a definite resistance to later intracerebral inoculations of the virus. It is inferred from this that in human abortive or nonparalytic cases the nature of the type of poliomyelitis may be a result of previous natural exposures to the virus in small amounts.

Special experiments carried out by Faber indicate that the concept of poliomyelitis as an air borne disease acquired by inhalation of contaminated air or dust deserves more consideration. However, the infrequency of development of poliomyelitis in the wards by workers therein speaks against such a spread.

An Industrial Medical Center. B. Crosthwaite.

Brit. J. Phys. Med. 7:168 (Nov.-Dec.) 1944.

Ultraviolet and infra-red irradiation are used for certain skin conditions and in the treatment

of conditions arising out of employment where such treatment would permit continuance at work. Massage and manipulation are carried out during rehabilitation at work and have resulted in a considerable saving of production loss and loss of wages to workers. The management of the spa has agreed special fees for treatments and medicinal baths, the fees barely covering the outlay involved. In addition there are provided daily, free of charge, as much of the hypotonic and hypertonic saline spa waters as required. The local hospital, which was formerly the "Royal Bathing Establishment," still retains much of the usual spa facilities and these are available to all workers as contributors to the hospital. The problem is for workers to find time, owing to the necessity for overtime work and a reluctance to utilize week-end leisure for the purpose. It is felt, therefore, that much useful work can be done at the medical center by the carrying out of essential treatment during working hours.

The Problem of the Infected Hand. E. C. B. Butler.

Clin. J. 2081:241 (Nov.-Dec.) 1944.

In the past there have been two great faults in the out-patient treatment of infected hands. First, insufficient stress has been given to restoring function to the whole hand in addition to the infected part of it; this was due to lack of co-operation with the department of physical medicine. The second fault was the pernicious habit of routine postoperative salt baths, a treatment which led in many cases either to secondary infection or to spread of the infection from imperfect immobilization.

According to the author the essentials of the treatment of infected hands are a sound knowledge of anatomy, accurate diagnosis which can be achieved only by experience, rest to the inflamed part before and after operation, a knowledge of the uses and limitations of chemotherapy and the closest cooperation with the physical therapist, so that the patient may get his hand and his confidence restored to him as quickly as possible.

Trench Foot. Report of 351 Cases. Joseph C. Edwards; Morris A. Shapiro, and Jennings B. Ruffin.

Bull. U. S. Army Med. Dept. 83:58 (Dec.) 1944.

The first principle in the treatment of trench foot is to rest in a cool place, keeping the body comfortably warm and clean. This is done by daily washing with 70 F. soapy water, gentle drying of the feet and either cooling the surface of the feet by air currents from a fan or by exposing them to room temperature not exceeding 70 F. but preferably about 50 F. This and absolute bed rest promote vasoconstriction and decrease local metabolic requirements. The body should be warm with enough blankets to make the patient comfortable. As soon as the acute pain has passed the patient is started on passive vascular exercise. He elevates his feet at an an-

gle of 45 degrees on a board or chair for two and later five minutes; keeps legs horizontal for five minutes; then sits with his feet over the edge of the bed for two and later three minutes, followed by resumption of the horizontal state. This is repeated three to four times daily during the week or so while the patient is at bed rest. This with calisthenics in bed each morning conducted by the ward master, helps keep these patients in good physical condition. Cool water soaks and whirlpool baths at 70 F. for twenty to thirty minutes daily helps temporarily. Whether or not they shorten the recovery period was not established. Not all patients could stand the cold water. Some found it relieved the aches and pains during the time the feet were in the water. Those with painful, swollen, warm feet usually did obtain relief. It is used empirically and those who obtained relief were allowed to continue the treatment. Cooling the feet at bedtime would enable many to get sleep without sedatives or analgesics.

All patients were reassured as to their eventual recovery. Lectures were given on the proper care of the feet. Undue exposure when not absolutely necessary was stressed. As soon as they were able, they were out of bed part of each day. From two to seven days later, depending on the severity of the condition, they were allowed to go to mess hall outside the ward. It is important to realize that most of these patients, on walking, have aches and pains in the muscles and metatarsophalangeal joints for several weeks after the feet appear normal. After they cease to have pain during ordinary walking, many overcome slight aches after hikes by persisting in walking even though the feet ache for the first few days. Occupational therapy, reading, writing, games and entertainment for bed patients, and outdoor exercise for the ambulatory are essential. When they are safely ambulatory, their attendance is required at daily organized hikes, which are gradually increased in length with the patients' condition. As soon as they are able to walk 3 to 5 miles without undue trouble, they are ready for duty.

Treatment by Movement.

Brit. M. J. 4379:771 (Dec. 9) 1944.

Sir, I read with interest Dr. James-Cyriax's article in the Journal of Sept. 2 (p. 303), and should like to be associated with him in stressing some of the points, at the same time criticizing others. His article deals with: Treatment by movement as soon as possible and choice of type of therapeutic movement, which varies from tissue to tissue, with the nature, position, and extent of lesion, with the integrity or not of such structures as nerve or bone and with the presence or absence of bacterial infection; modern methods in the treatment of fractures; the need for deep massage in certain strains of ligaments and muscle attachments working over bone, and in cases of tenosynovitis; the use of passive movement in addition to active movements to maintain or restore full joint movement, and the use of faradism only in initial stages.

I am glad that Dr. Cyriax drew attention to the need for deep massage in certain cases, as the teaching is so much against massage in general that it is often denied to cases in which it should be the main treatment. I would like to add to his list of suitable cases enlargements of infrapatellar pads of fat and collections of organizing hematoma in places where there are no muscles. I am certain that Dr. Cyriax would be first to agree that other forms of physical treatment, such as anodal galvanism, diathermy, heat and faradism, are a great adjunct to massage.

I am surprised that he uses the phrase "passive movement," and I agree with Watson-Jones that the term should be used only in cases of paralyzed muscles. Dr. Mennell has stressed the importance of the range of involuntary movements possessed by each individual joint and how important these movements are for free painless active movement.

It is evident then that every mobile joint has a range of active voluntary movement and involuntary movement. These involuntary movements allow for gliding of one bone on the other, rotary movements and side bending. If after a simple sprain of a joint there are pain and limitation of movement at the end of two months, most orthopedic surgeons would recommend a manipulation of the joint under anesthesia, but if gentle manipulative movements are carried out as part of the other treatment, such exercises, massage, contrast baths and faradism, it is seldom that there is not a return to full range of joint movement in any sprained joint at the end of three weeks. Therefore I suggest that it would be better to delete the phrase "passive movement" and substitute "gentle manipulative movements." Apart from that, the methods of applying the manipulative movements are quite different, and, as Dr. Mennell points out, passive movements themselves are the cause of inflammatory reactions and increased stiffness, which gentle manipulative movements never produce.

Another important distinction in active movement, which I did not consider he brought out, is the difference between isometric and isotonic movements. With an injured limb in plaster, movements will be isometric, the muscle contracts and broadens, but does not lengthen. As the joint has been placed in the optimum position of rest, movements of this type will prevent wasting of muscles and overstretching of the anti-gravity muscles, and at the same time hasten the absorption of traumatic effusion. In isotonic movements, although the tone in individual muscle fibers is equal, stretching and alteration in the length of the muscle take place. This may lead to overstretching of one group of muscles with contraction of their antagonistic group.

Faradism given properly throughout aids and encourages active movement, and allows each muscle of a group to be actively stimulated individually, so that one muscle works on the other, preventing intermuscular adhesions. This is not allowed by active group movement alone, and one only has to see cases treated by exercises

plus faradism, compared with those treated by exercises alone, to appreciate the difference in recovery time.

Treatment of Fractures in Relation to Functional Result. Edward Harlan Wilson.

Ohio State M. J. 41:38 (Jan.) 1945.

Modern treatment of fractures is generally considered to have begun when the use of the roentgen ray, in connection with the treatment and diagnosis of fractures, became general. As the general use of roentgen rays did not begin until about 1905, only a brief period of time elapsed before World War I occurred, with its mass demands for treatment of every conceivable type of fracture injury. Since fracture treatment had developed on an individual basis, the War served to simplify and standardize the individualistic methods which had been in use.

According to the author a word should be said about rehabilitation of the person once the fracture has become healed. Physical therapy is a useful measure in the transitional stage following nonuse. Beginning movements are painful due to the positional contracture of muscles and to the fibrosis of soft tissues from injury to them at the time of fracture.

The essence of physical therapy is to teach the patient to move the limb through a gradually increasing range of painless motion. If motion is begun gently and does not impinge on painful limits, the patient will rapidly gain confidence, increase the range and become quite cooperative. If he is told simply to go out and begin moving the limb he will use it in an ungoverned manner which will cause sharp reaction of pain and muscle tightening. This is quickly converted into an exaggerated idea of guarding the limb from all motion.

Once physical therapy has brought about a fair range of motion, exercises against resistance should be instituted to increase the power of the muscles. Once this stage has been attained, physical therapy alone will not suffice and must be either accompanied by or supplanted by more active forms of activity. In the case of workmen it is especially important that employers take them back and furnish light, restricted work which will further aid the persons in rapid restoration of ability to perform full duty.

Recent Advances in the Treatment of Peripheral Vascular Diseases. Gordon E. Jones.

West. J. Surg. 52:497 (Dec.) 1944.

Successful efforts to increase peripheral blood flow by physical measures have been limited to the expedient of intermittent venous occlusion. This simple mechanical phenomenon can be achieved by means of Buerger's passive vascular exercises, an intermittent venous occlusion apparatus, or by an ordinary blood pressure cuff and an attendant taught to operate it properly. The purpose of any of these methods would be to bring about an intermittent and rhythmic venous distension with alternate periods for emptying the

vascular bed. This therapeutic measure is based on sound experimental data and has been found to work repeatedly in actual clinical trial. The conclusions of Friedland and Wilkins, based on experimental work which failed to demonstrate an increase in blood flow during venous occlusion, are not necessarily applicable to the effects of intermittent venous occlusion on peripheral blood flow. Their observations are at variance with the work of other investigators.

Refrigeration anesthesia for amputation has been unreservedly advocated by Allen and others. The technic, as described by several authors is essentially the same in most details. Proponents of the method state that this type of anesthesia lowers the mortality, reduces shock and makes surgery possible in some cases that might otherwise be hopeless. They all agree that one disadvantage is a delayed healing time.

The refrigeration technic, when properly performed with utmost attention to detail, gives satisfactory anesthesia for almost any type of amputation. The method, however, is time consuming and is cumbersome and messy. Strict aseptic technic is difficult to maintain. The principle of using a tourniquet proximal to the site of amputation in a patient with poor peripheral circulation is a poor one. Crossman's mortality rate of 15.5 per cent in 45 patients anesthetized with this technic is not impressive. The method will be attractive to those who have had anesthesia difficulties but it does not appeal to those who have performed amputations simply and safely under a very low unilateral spinal anesthesia such as can be obtained with as little as 50 mg. of procaine hydrochloride.

Refrigeration anesthesia is a valuable adjunct in certain types of cases. Cooling has the great advantage of arresting the metabolism of both tissue and bacteria and can therefore be used to "freeze" a septic or gangrenous process while a very ill patient such as a diabetic in acidosis can be prepared for surgery. Crossman reports the case of a poor risk patient with a popliteal embolus in whom the extremity was refrigerated for sixteen days before gangrene developed. The method is also of value in the handling of a mangled extremity when the patient needs to be treated for shock.

Nasogenic Asthma. Clive Shields.

Brit. J. Phys. Med. 7:177 (Nov.-Dec.) 1944.

Treatment falls conveniently under three headings, instruction in the correct manner of breathing; attention to the nasal factor and the resolution of any psychologic, social or environmental factors which may be discovered and measures for the correction of chemical or metabolic abnormalities.

In teaching breathing exercises to the patient he should be instructed that physically his condition is due to the fact that while he is able to get air into the lungs he experiences difficulty in expelling it.

It should be made clear that inspiration consists of three phases or stages; an expansion of the base of the lung by the descent of the diaphragm; an expansion of the middle zones of the chest by a lateral or sideways movement of the lower ribs and an expansion of the upper zones by a forward and upward movement of the upper ribs.

To teach correct expiration the patient is first asked to imagine a collection of dust in the angle formed by the ceiling and wall opposite the couch. Next it is explained that expiration consists of two phases without any interval between, and that it should be in the nature of a long-drawn-out sigh.

There is often an increased cough and expectoration in the early stages of treatment as the basal expansion improves and this is to be regarded as a hopeful sign.

Artificial Fever Therapy. E. P. Cayo.

Texas State J. Med. 60:333 (Oct.) 1944.

For the induction of artificial fever, only one thing is required and that is heat. Heat may be applied to the body by means of warm dry air, warm moist air, warm water, or it may be generated in the body by means of diathermy. Of all these methods we have found warm moist air (a saturation of about 90 F.) to be the most satisfactory, and this is the degree of saturation we use in all of our work. This saturation is used with a cabinet temperature that seldom reaches 120 F.

As soon as the temperature reaches 100 F. the administration of oxygen by means of nasal catheter is instituted, and is allowed to flow at the rate of 4 liters per minute. When the pulse rate passes 130 per minute the flow is increased to 6 or even 8 liters per minute. As soon as the patient begins to show signs of discomfort a sedative drug is administered. We generally use morphine sulphate in from $\frac{1}{8}$ to $\frac{1}{4}$ grain dosage. This drug may be repeated in thirty minute if the patient shows no effect from the first dose. In rare cases, $\frac{1}{8}$ or even $\frac{1}{4}$ grain of morphine sulphate may prove sufficient for an entire treatment, while in other cases as much as one grain of the drug administered in doses of $\frac{1}{4}$ grain every 30 minutes may be required to get the desired sedation. When it is found that a patient is nauseated by morphine another drug should be selected. All other things being equal, as little sedative as possible should be used to keep the patient comfortable.

Fluids should never be forced, at least not to such an extent as to cause nausea and vomiting. In the treatment of neurosyphilis, the best results are attained by continued fever-chemotherapy. Experience is proving that fever therapy to be most effective should be sustained at about 106 F. Temperatures of 103 or 104 F. seem to have little value.